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ABSTRACT

The history of German universities and research institutions is part of the history of the culture of Europe and its university systems. This book surveys the history, structure, and promotion of the German university system. Discussed are the diversity of structure; differentiated assistance; the promotion of science in the federal state; freedom of research, teaching, and studies; the relationship of universities to industry; and links with science abroad. The organization and character of universities and academies are described. The programs of several science centers and libraries along with universities are surveyed. Appendices include a list of colleges and universities in West Germany, a chart of major research emphases by institution, and a list of 44 sources of further information. (CW)

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Organisation and Promotion of SCIENCE in the Federal Republic of Germany

SE049 715

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A Introduction

Science in the Federal Republic of Germany
– a survey of its history, structure, and promotion[1]

Past and Present

The history of German universities and research institutes is part of the history of European culture and its university system. Bologna (1119) and Paris (1253) were models for the first universities in the mediaeval German area, Prague (1348) and Vienna (1365). The first universities in the areas that today constitute the Federal Republic of Germany – Heidelberg (1386) and Cologne (1388) – and the GDR – Erfurt (1392), Leipzig (1409), and Rostock (1419) – were also among the oldest universities established in Europe.

Many other universities were set up in the 15th and 16th centuries in the course of the clash between scholasticism and humanism, and of the struggle between the Reformation and the Counter-Reformation. Not all of these were destined to survive. Over half of the 42 universities that existed in the German-language area in 1792 just after the French Revolution had been closed down by the end of the Napoleonic Wars in 1813/14. After a degree of ossification and pedantification in the 17th century, the age of the Enlightenment and the increasing importance of mathematics and the natural sciences brought renewed stimulation. The establishment of the university of Göttingen (1737) was particularly important – a foundation in the spirit of the Enlightenment which took into account the development of mathematics and the empirical sciences then making their way alongside the practical demands of the 18th century. Most universities were founded by the rulers of the German territorial states formed towards the end of the Middle Ages. Their names often bear witness to that. In Berlin in 1810 there was established – under the influence of the conflicting views of Friedrich Wilhelm Joseph Schelling, Friedrich Daniel Ernst Schleiermacher, Wilhelm von Humboldt, and Johann Gottlieb Fichte – who became the first Rector in 1811 – a university that, as an institution embodying reform, for long shaped the character of German universities and also served as a model in the setting up of many universities in other countries.

[1] The German terms "Wissenschaft"/"wissenschaftlich" have been translated throughout by "science"/"scientific". It should be noted that this covers the whole range of academic disciplines, i. e. it is not restricted to the natural or exact sciences.

The first scientific academies in the German language area arose in the 17th and 18th centuries as learned societies. Towards the end of the 18th and to an even greater extent in the 19th century, there developed, alongside the universities and academies of science, the technical colleges and other institutions specialising in a few subjects, such as the Colleges of Agriculture. Governmental and private research institutes were also set up outside the universities to a greater extent. There was an increase too in the number of laboratories at work in those branches of industry where research was intensively pursued.

Today people's lives are shaped by technical inventions and social changes resulting from research in the natural sciences and medicine. Researchers and engineers at work in Germany have contributed a great deal there. In 1876 Robert Koch discovered the causes of anthrax, tuberculosis, and cholera, and thus established bacteriology. Emil von Behring developed diphtheria serum in 1890, initiating treatment by serum. Paul Ehrlich is viewed as having launched chemotherapy. At the beginning of the 19th century, Albrecht Thaer took agriculture beyond mediaeval forms of cultivation, and Justus von Liebig later founded modern agrochemistry. Medicine and agriculture created the preconditions for a rapid growth of population and an increase in food production. In 1866 Werner von Siemens discovered the principle of electrodynamics and constructed his dynamo, which marked the beginning of electrical engineering. Fritz Haber and Carl Bosch synthesised ammonia from atmospheric nitrogen and hydrogen in 1913, a turning-point in chemical process engineering as a whole. In 1876 Nikolaus August Otto built an internal combustion engine utilising a four-stroke system for the first time, the first petrol engine. Rudolf Diesel invented and developed the motor named after him at Augsburg in the years between 1893 and 1897. Max Planck's quantum theory (1900) and Albert Einstein's special and general theories of relativity (1905 and 1916) provided – together with Heisenberg's later work on the quantum theory (1925 – 27) – the basis for our age's scientific view of the world. In 1939 Otto Hahn discovered the fissionability of uranium.

It is not surprising that, against the background of such a tradition (whereby philosophers such as Immanuel Kant, Johann Gottlieb Fichte, Georg Wilhelm Friedrich Hegel, and Friedrich Nietzsche should not be forgotten), science and research always enjoyed a high reputation among Germans, and its contribution to technical, economic, and cultural development, and to the solution of social problems, was expected and welcomed. Scientific and technical progress did not just entail better provision of broad sectors of the population with material goods and improvement of working conditions in an ever broader spectrum of spheres of ac-

tivity. More extended access to a diversified education system and the associated chances of advancement, and the development of democratic forms of state in Western industrial countries with considerable area of freedom for the individual, were also linked with progress in science and technology.

At the same time though, awareness is increasing that greater efforts have to be made in order to recognise the interrelationships between and the impact of technological developments, and also to weigh and discuss their opportunities and risks.

Responsibility here is born by scientists, politicians, and social groups involved in an ongoing public dialogue in which extensive sectors of the population also participate. The Federal Government is therefore assisting a diversity of investigations into the impact of new technologies, and it is also promoting public awareness of nuclear energy, the large-scale introduction of micro-electronics, and the opportunities and risks involved in genetic research. The German Federal Parliament participates in these discussions of the consequences of technological change by way of its own commissions of enquiry.

The objective in these discussions is to win over the critical public for differentiated comprehension of technical change. The forms of change being discussed in the Federal Republic of Germany are problems facing all industrial nations where science and technology advance into ever-new spheres and are faced by new issues in scientific and ethical responsibility. People also know in the Federal Republic though that the equally significant problems of other nations cannot be solved without the responsible and meaningful organisation of science and technology. That is also taken into account in scientific and technical co-operation with the Third World.

Diversity of Structure

There are four main characteristics involved in the structures of science in the Federal Republic of Germany: its rich diversity, a well-developed system of financing and assistance, a great degree of freedom for the researcher in his choice of areas of work and methods, and a close link with scholarship in other countries.

This diversity is chiefly apparent in the universities – wissenschaftliche Hochschulen –, which in the Federal Republic of Germany means universities offering the chance of gaining a doctorate: the universities, technical universities and colleges, medical and veterinary universities and colleges,

comprehensive universities, and colleges of education. These universities pursue the totality of science within a large range of individual subjects. The universities – wissenschaftliche Hochschulen – in the Federal Republic of Germany employ some 100,000 scientists (see table 5, P 30). Most of these are involved in both research *and* teaching (in the training of students and in care of the sick in medical clinics) so only a percentage are viewed (for purposes of statistical comparison) as being researchers. Table 1 (P 17) shows the personnel (adjusted to correspond to full-time employment in this sphere) engaged in research and development. That amounts to a potential of around 30,000 researchers in the universities. Apart from the universities there are four other extensive spheres of research:

1. Independent co-ordinating organisations such as the Max Planck Society with 55 institutes and groups of scientists concerned with fundamental research (P 32 ff) and the Fraunhofer Society with 33 institutes devoted to applied research (P 34 ff).
2. 13 "big science" national research centres in the spheres of nuclear research, and other important areas of the natural sciences, medicine, and technology (P 35 ff).
3. Federal and Laender research facilities subordinate to individual Ministries, which pursue research into important public tasks, together with the research institutions of national significance jointly financed by the state and the Laender (P 40 ff).
4. Research in individual firms and joint industrial research (P 43).

In quantitative terms, university research amounts to only about a third of the potential in other institutions largely or completely financed by the state and in industry's research and development laboratories, but account must also be taken of the high developmental element in industry and of the difficulty in making a distinction between the testing phase and the start of actual production. Tables 2 (P 18) and 3 (P 19) enable comparison between staff (divided into spheres of study) at the universities and at non-university research institutions funded by Government. The great superiority of universities' research potential in the humanities, social sciences, and medicine becomes apparent there. Outside the universities there is great potential – particularly in national research centres, Max Planck institutes, and Federal or Laender institutes – for work in the natural and agricultural sciences. Engineering takes an intermediate position in such comparative staffing ratios.

Differentiated Assistance

Table 4 (P 20) provides an idea of the amount of money devoted to financing research. The total spent on research and development amounted to over 52 milliard DM in 1985. Somewhat under a half was provided by the state, and somewhat over a half by industry. Two thirds of the money went to industry, and the remaining third was about equally divided between university and non-university research facilities.

The system of provision of finance and assistance for research in the Federal Republic of Germany is so extremely complex and sometimes so complicated that even experts occasionally have difficulty in understanding it. The reasons for this diversity lie, firstly, in the federal structure of our state and the division of powers anchored in the constitution; secondly, in a marked emphasis on the autonomy of science, which is guaranteed in the constitution; and, thirdly, in our market-economy system which allows scope for the free initiative of industry and the foundations in the financing of research.

Promotion of Science in the Federal State

The Basic Law, the constitution of the Federal Republic of Germany, assigns the Laender as the member states[1] all the tasks and authority of state provided that the Basic Law does not itself determine otherwise or admit another regulation.

Such regulations apply to:

1. Assistance for training and for the promotion of scientific research (Article 74, clause 13, Basic Law). The federal authorities thus in 1971 implemented a law for the provision of assistance for training (Bundesausbildungsförderungsgesetz – BAföG), which regulates assistance for education at schools, technical schools, and universities. They did not, however, draw up a law for the general promotion of research, even though this lay in their powers.
2. The general principles underlying the university system. The federal authorities have the right to enact legislative guidelines in this sphere (Article 75, clause 1, Basic Law). The Framework Act for Higher Edu-

[1] Baden-Württemberg, Bavaria, Berlin (with special status), Bremen, Hamburg, Hesse, Lower Saxony, North Rhine-Westphalia, Rhineland-Palatinate, Saarland, Schleswig-Holstein

cation (Hochschulrahmengesetz – HRG) was thus passed in 1976 and amended in 1985. Most of the regulations contained in this law provide a framework for legislation by the Laender. The law also includes sections on universities' tasks in research and teaching, on admission to studies, and on staffing structures.

3. The conclusion of limited contracts with scholarly staff. The law (Zeitvertragsgesetz, 14. 6. 1985) regulating short-term contracts of employment for scholarly staff at universities and research institutes establishes possibilities of limited contracts above and beyond the existing provisions in the laws and general contracts concerned with wages and working conditions.
4. The involvement of the federal authorities in joint Federal-Laender tasks (Gemeinschaftsaufgaben). These include the construction and extension of universities inclusive of university clinics (Article 91a, para. 1, clause 1, Basic Law). The Law for the promotion of university building (Hochschulbauförderungsgesetz – HBFG) was thus introduced in 1969. This law made possible an extensive building programme for expansion of the universities' capacity to admit a mounting number of students, and to adapt existing facilities to constantly changing teaching requirements (as in the employment of micro-computers) and also equip them with large-scale equipment for research.
5. The co-operation of the federal and Laender authorities on the basis of agreements about educational planning and assistance for research facilities and projects of national importance (Article 91 b, Basic Law). This provided the basis for the 1975 outline agreement between the federal authorities and the Laender on joint assistance for research, which serves to finance the German Research Society and special collaborative programmes, the national research centres, the Max Planck Society, the Fraunhofer Society, a further fifty or so institutes and subsidiary service facilities, and the academies' joint research programme. The Heisenberg Programme for highly-qualified young scholars and the Leibniz Programme for Selected Researchers and Research Groups also receive assistance under this agreement.
6. Federal statistics, which are exclusively a province of the federal authorities (Article 73, clause 11, Basic Law). The university statistics law (Hochschulstatistikgesetz) was thus passed in 1971.

Freedom of Research, Teaching, and Studies

The comprehension of autonomy traditional to our country is also underpinned by the constitution: "Art and science, research and teaching, are free." This freedom of teaching, does not absolve from loyalty to the constitution (Article 5, para. 3, Basic Law).

That receives dual expression in research and its financing. The individual researcher is free, particularly with regard to his choice of research subject, the basic principles of the methods employed, and evaluation and dissemination of his research results (Para. 3 of the Framework Act for Higher Education with corresponding sections in the Laender legislation). At his disposal are working hours, staff, rooms, energy, equipment, and funds, provided by the state. If these facilities are not sufficient, he can apply for additional assistance from the organisations and foundations providing help for research, and also from state bodies and industry. It is estimated that in this way the universities acquire some additional 2 milliard DM annually. There also applies in institutions the principle that scientists are responsible for their own work – in universities and the West German Rectors Conference, in research organisations based on self-administration such as the Max Planck Society, and in set-ups for the promotion of research such as the German Research Society (Deutsche Forschungsgemeinschaft – DFG). Scientists are also strongly represented in joint consultative bodies such as the Science Council.

Freedom of teaching particularly comprises the organisation and presentation of teaching activities, and the right to free expression of scholarly and artistic views within the framework of the tasks involved.

Freedom of study within the regulations governing studies and examinations especially involves a free choice between teaching activities, the right to choose one's own emphases in a course, and the formation and expression of scholarly and artistic opinions.

The Commitment of Industry

A further factor that has contributed to the complexity of the financing of research in the Federal Republic of Germany is the great and many-sided involvement of industry in research and development, not just in big firms but also to an increasing extent in small and medium-scale enterprises. These firms have their own laboratories for research and development, conclude contracts on co-operation, finance agreements on joint industrial research, and commission research from universities and other state-

supported institutions. The state also provides backing for industrial research by awarding contracts for research and development, supporting joint industrial research, and by a variety of other forms of direct and indirect assistance such as subsidies for staffing costs in research and development, subsidies for innovations, and tax concessions.

Close Links with Science Abroad

The traditional European view is that scholarship does not in principle know any frontiers. Nevertheless, free relations between scientists from different countries have often been restricted amid 20th century political developments as a result of the mounting technical, economic, and political significance of science.

Scientists in our country know the necessity and fruitfulness of the unhindered exchange of experiences, methods, and research results, and how important a role is played there by personal contacts, and joint work by researchers and their guests.

For its part the Federal Government assists international scientific relations both bilaterally and multilaterally. Many agreements concluded by the government include clauses on scientific co-operation and exchanges of scholars and researchers. The government also supports scientific co-operation in such international organisations as the United Nations (inclusive of the U.N. University), UNESCO, the OECD, the Council of Europe, and, not least, the European Community and efforts towards large-scale technological and scientific co-operation (EUREKA). The same applies to such extensive forums as the Conference on Security and Co-operation in Europe and the meetings that have followed.

A division of labour between state and non-state organisations has established itself in this sphere in the Federal Republic of Germany over the course of time. The German Research Society is, for instance, a member of the International Council of Scientific Unions (ICSU) and finances German scientists' participation in joint international projects and expeditions. The Society looks after the exchange of scientists with the Soviet Union while the Max Planck Society cultivates special relations with the Chinese People's Republic. Special mediator organisations such as the Alexander von Humboldt Foundation (A v H) and the German Academic Exchange Service (Deutscher Akademischer Austauschdienst – DAAD) are concerned with exchanges of scientists from all over the world (see P 94 ff).

All that takes place on a broad basis of specialised contacts between indi-

vidual researchers and institutes and their colleagues and partner organisations all over the world. It is undeniable though that, with the increase in the number of scientists and of scientific relations with the Third World, organisational assistance must be provided to an increasing extent.

Table 1

Staffing in research and development (converted to full-time employment) as of 1983

Sector	total	of whom		
		Researchers	Technical staff	Other
1. University sector	73,850	30,600	28,075	15,175
2. State sector[1]	47,623	19,227	13,983	14,414
3. Private scientific institutions[2]	2,500	1,420	595	485
4. Industrial sector[3]	249,478	81,867	76,949	90,662
Total	373,451	133,114	119,602	120,736

[1] State institutes inclusive of scientific set-ups largely federally financed.
[2] Private non-commercial scientific institutions, which are mostly not financed by the state (partly estimated).
[3] Without the Social Sciences and Humanities.
Source: Faktenbericht 1986 zum Bundesbericht Forschung.

Table 2

Staff in research and development (R&D) at universities (estimates converted to full-time employment)

Form of activity	total	of whom				
		Natural Sciences	Engineering	Medicine	Agriculture	Humanities and Social Sciences
Total R & D staff in universities[1]	73,850	19,950	12,500	22,250	3,125	16,025
of whom:						
1. Researchers[2]	30,600	9,375	5,725	4,875	1,000	9,625
2. Technical staff[3]	28,075	7,625	4,800	8,600	1,250	5,800
3. Other staff[4]	15,175	2,950	1,975	8,775	875	600
Additional information: Researchers in non-university scientific institutions[1 & 5]	19,227	9,922	3,417	1,865	1,179	2,844
Ratio of non-university to university researchers	39 : 61	51 : 49	37 : 63	28 : 72	54 : 46	23 : 77

[1] 1983 estimated, converted in accordance with R & D coefficients
[2] Scholars inclusive of graduate engineers
[3] People with Technical School or similar qualification exclusive of graduate engineers
[4] Administrative staff, manual workers, and other personnel
[5] in accordance with OECD coefficients

Source: Faktenbericht 1986 zum Bundesbericht Forschung

Table 3

Staff in non-university scientific institutions
– as of 1985[1] –
(full-time employment)

Nature of institution	total	of whom				
		Natural Sciences	Engi-neering	Medi-cine	Agri-culture	Humani-ties and Social Sciences
1. National research centres	19,417	14,056	4,289	1,072	–	–
2. Max Planck Institutes	7,989	5,302	196	1,674	219	598
3. State institutes (exclusive of libraries, archives, museums)	16,601	6,076	1,815	2,461	4,849	1,400
4. Fraunhofer Institutes	2,823	1,445	1,036	107	63	172
5. Scientific libraries and archives	5,800	–	–	–	–	5,800
6. Scientific museums	3,680	2,576	–	–	–	1,104
7. Other research institutions	5,239	921	498	1,382	22	2,416
Non-university scientific institutions						
Total	61,549	30,376	7,834	6,696	5,153	11,490
of whom R & D	49,459	27,582	7,369	5,485	3,294	5,729
Additional information: Universities (est. R & D equivalent converted to full-time employment) as of 1983.	73,850	19,950	12,500	22,250	3,125	16,025

[1] Provisional figures, partly estimated

Source: Faktenbericht 1986 zum Bundesbericht Forschung

Table 4

Resources devoted to science and total expenditure on research and development in the Federal Republic of Germany

a) Resources devoted to science[1]
(1985)
– Million DM –

Source of financing	
1. Public budget	
1.1 Federation	14,979
Laender and local authorities[2]	23,381
1.2 Scientific non-profit-making organisations[3]	716
Total of 1	39,076
2. Business sector[4]	
2.1 Trade and industry	30,780
2.2 Foundations and donations	450
Total of 2	31,230
Total of 1 & 2	70,306

[1] R & D Expenditure and expenditure for academic teaching and other outlays
[2] for local authorities estimated
[3] Expenditure financed from the income of institutions largely supported by the state (estimated)
[4] Estimated

b) Total expenditure on research and development[1]
(1985)
– Milliard DM –

Funds for	Provided by Federal authorities	Laender & local authorities	State total	Industry	other sources[1]	total
Universities	1.3	5.5	6.8	0.4	0.1	7.2
Non-university research institutes[2]	5.6	1.8	7.5	0.8	0.1	8.3
Industry	6.1	0.4	6.4	29.7	0.6	36.7
total	13.1	7.6	20.7	30.7	0.8	52.2

Differences of Minor discrepancies result from rounded-off figures

[1] Including foundations and other private national institutions plus money from abroad
[2] Federal and Laender institutions, private non-commercial institutions (such as national research centres and the Max Planck Society), and institutes abroad inclusive of international research set-ups

Source: Faktenbericht 1986 zum Bundesbericht Forschung

B Scientific Institutions

I. *Institutions of Higher Education*

1. Organisation and Structure

The Institutions of Higher Education serve, in their specific ways, the cultivation and development of the sciences and arts by way of research, teaching, and study. All of them share the task of preparing students for employment that demands utilisation of scientific knowledge and methods or a creative ability in the artistic field. The following forms of university exist in the Federal Republic of Germany:

1. The universities – wissenschaftliche Hochschulen:
- Universities inclusive of Technical Universities/Technical Colleges and other specialised institutions of similar standing such as Medical, Veterinary, and Theological Colleges. These offer courses of study in scientific subjects, usually extending over four or five years.[1]
- Comprehensive Universities (Gesamthochschulen). These include both university and Fachhochschulen courses, and also to some extent art college courses. These courses can either be integrated (Short and longer studies with the same foundation course) or separated in terms of university spheres.
- Colleges of Education (Pädagogische Hochschulen) inclusive of Institutes of Education (Erziehungswissenschaftliche Hochschulen). These mainly serve teacher training. In several of the Laender the Colleges of Education are no longer independent organisations but are integrated in Universities or Comprehensive Universities. Studies usually take 3 or 4 years.

2. Art Colleges – for the visual arts, design, music, and film and television. Studies usually take 4 or 5 years.
3. Fachhochschulen, which have largely been established from earlier Schools of Engineering and Technical Secondary Schools. Three-year courses of study provide practically-oriented training for vocations demanding the application of scientific knowledge and methods. In some Laender seminars of practical training are also included in these courses (see P 26).

Table 5 (P 30) gives a survey of universities, the academic staff, and the number of students.

[1] often exceeded in practice

Universities and colleges in the Federal Republic of Germany are – with just a few exceptions such as a number of Church Colleges and three private institutions – state establishments, which are financed by the Laender (except for the two Federal Army Universities). The Laender provide the money for the regular staff and for running costs. The federal authorities contribute towards the costs of university construction and expansion, and towards providing universities with large-scale scientific equipment (see P 14). People employed full time at universities are usually employees of the Land concerned. The Professors are appointed, in accordance with a university's recommendation, by the authority laid down by the Land law, which is usually the Land Minister of Education. The University is headed by an elected President or Rector whose appointment also has to be confirmed by the authority designated in the Land law.
The Federal Framework Act for Higher Education provides for representation of university members in various committees being organised in four groups: 1. the professors, 2. the students, 3. the lecturers, assistants, and academic and artistic staff, and 4. other staff. All these groups have a seat and a vote in the most important university bodies. Professors must, however, have an absolute majority of seats and votes in such bodies.
The universities are organised in departments or faculties whose spokesmen or deans belong by virtue of their office to the central organs of administration. There are also special scientific facilities as in the sphere of medicine, and central administrative units.
The universities have the right to self-administration within the framework of the law. They endow themselves with basic regulations which must receive the approval of the Land concerned. Both university self-administration and the rights of individual members are legally assured.

2. University Expansion

The traditional German university was equipped for the scientific training of a relatively small number of students. Only some 5 to 7% of any age group went to university. Today though our democratic society strives for equal educational opportunities for all. These opportunities are taken up by an ever increasing number of young people. Today there are over a million students at universities in the Federal Republic of Germany, which amounts to around 21% of the age groups concerned (with around 15% at universities and 6% at Fachhochschulen).
The universities have opened themselves up to these large numbers of stu-

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dents but are faced with the problems of "mass study". The length of time devoted to studies was already longer (as a result of freedom of study) than in many other countries. The length of study courses has increased even further as study conditions have become more difficult in what are often overcrowded universities. The rush for certain faculties has in turn led to restrictions on admission, mainly in medicine, pharmacy, biology, psychology, and architecture. That has been accompanied by greater legal regulation of university entrance with restrictions on the number of students to be admitted and on the lectures to be held by university teachers.
The state authorities and the universities otherwise attempt to cope with the challenges of these great and still increasing numbers of students in two main ways:
Firstly, the Federal and Laender authorities have invested considerable sums of money in the rebuilding and expansion of the universities. In the past two decades, 17 universities, 9 comprehensive universities, and 2 medical colleges and numerous new Fachhochschulen have been built. The subjects on offer at a large number of existing universities have been extended by the establishment of new faculties and spheres of study so that today most universities offer a broad range of subjects. For a number of years now the Laender have also been implementing special programmes for alleviation of overcrowding. Assistance measures, restricted to a specific period, are intended to increase universities' training capacity whilst the demand for study-places remains high.
Secondly, courses of study are gradually being transformed in terms of both content and organisation. New teaching and working methods are being introduced. Above all, there is to be greater emphasis on taking into account the vocational realities that will later face students, and the social interrelationships extending beyond the subject involved.
The academic staff also grew along with the expansion of the universities. The number of scheduled posts at the scholarly universities quadrupled during the past two decades from some 17,000 in 1960 to around 70,000 in 1981, and then stayed roughly at that level. The same is true of the Fachhochschulen where the number of academic staff increased from some 2,200 to around 9,000. In addition there are the staff members paid for out of supplementary funds. If account is taken of possible overlapping appointments of academic and auxiliary graduate staff, the outcome is a potential of around 135,000 scientists at the institutions of higher education in the Federal Republic of Germany (Table 5, P 30).

3. Characteristics and Structural Problems of University Research

Research is pursued at universities in the Federal Republic in close conjunction with teaching, i.e. students' training needs are also taken into account. The typical research institute is an exception at the universities. In the present period of large numbers of students, that also signifies that research tasks with their demands on staff, money, and, above all, time compete with the university's teaching function. On the other hand, this link constitutes a great advantage. The training of students both provides the university with a new generation of young scholars, and constantly gives fresh impetus to university research. The university thus also makes a contribution to all non-university research activities and to all activities where scholarly training is requisite.

Universities in the Federal Republic of Germany continue to be a sphere of fundamental research. A link between theoretical and applied research is mainly to be found in clinical medicine, engineering, agriculture, and, to an increasing extent, in economics and the social sciences. Many universities develop special activities devoted to furtherance of the transfer of technology, supported by both the federal authorities and the Laender.

Mention was made at the start of the diversity of research at universities. In no other sphere of science in Germany is the spectrum so broad, even though there are differences from university to university. Such diversity also entails that university research – particularly in the humanities – is pursued in relatively small work-units. These seldom attain the size of, say, a Max Planck Institute, let alone a national research centre. Research projects involving just one or a few scientists are frequent, large-scale enterprises seldom.

This division into many small units makes it easier for the universities to cover the entire range of research in a multitude of individual projects. On the other hand, that creates problems as far as contributions to the solution of complex issues entailing high expenditure over a longer period are concerned. Many of the questions and tasks involved in our economic, social, and cultural existence, where answers and suggestions towards solutions are expected from scientists, are, however, of a complex nature. There is also the fact that rapid expansion of the university system – and not only of the system as a whole but of the individual university, which often became a huge enterprise – was naturally primarily concerned with the requirements of teaching and studying. That did, nevertheless, also contribute to a considerable increase in research potential.

Now that the phase of expansion has come to an end, the concept of differentiation is increasingly making its way, accompanied by the view that the advancement of research follows different priorities to the augmentation of teaching. The requirements of research – particularly for expensive equipment in the natural sciences and engineering – are constantly mounting. Concentrations of effort must therefore be established among and between the universities. The Science Council also spoke in favour of such differentiation and establishment of specialisations in its 1979 recommendations on research and the deployment of funds in universities, and in 1985 recommendations on competition in the German university system.

4. Emphases in University Research

Special methods for assisting the creation of specialisations at universities have been developed in the Federal Republic of Germany during the past three decades.

The German Research Society (see P 57ff) has since the start of the 1950s been assisting priority programmes in which researchers from various scientific institutions and laboratories work together on a comprehensive topic or more extensive project for a limited period, which is usually at least 5 years. The people involved work in their own research base. The survey on P 120ff of the appendix shows the present priority programmes in such research, extending over all the main spheres of science.

A new instrument for establishment of research emphases was created in 1968 on the recommendation of the Science Council. At present there are around 160 "Special Collaborative Programmes" where scientists of various disciplines from a single university and sometimes also from nearby research institutes cooperate in the framework of a research programme. The special feature of these "Special Collaborative Programmes" is the co-operation in one place between researchers from different faculties.

Such "Special Collaborative Programmes" are usually established for periods of between 12 and 15 years. They are not new institutes but they do bring together various research units to participate in a joint task. This programme now receives over 300 million DM in finance from the German Research Society. Such a special collaborative programme receives an average of 2 to 3 million DM annually inclusive of funds for large-scale scientific equipment in addition to the university staffing and equipment budget. In exceptional cases, money can also be provided in this programme for high investment of a special nature such as a research vessel

for a Hamburg project and a wave channel for research into coastal protection by the Hanover Technical University.
Three-quarters of the funds for this programme are provided from the budget of the Federal Ministry of Education and Science, and a quarter from the budgets of the Laender Ministries of Education or Science. This is different from the usual arrangement for joint financing by the federal and Laender authorities where costs are equally shared. As the overview on P 114ff of the appendix shows, these "Special Collaborative Programmes" also cover the entire range of research interest but there is particular emphasis on the bio-sciences and the natural sciences.

5. Fachhochschulen

The Fachhochschulen were established in 1970 and 1971, and today they constitute an established element within the system of higher education. Study at a Fachhochschule is mainly characterised by special emphasis on the applied aspects of the course, strict planning of studies and the subject-matter covered, and a shorter period of studies than in the universities – wissenschaftliche Hochschulen. Studies usually take 3 years (4 years where Laender prescribe a traineeship). Around half of the 260,000 or so students at the General Fachhochschulen study branches of Engineering, and about a third are concerned with Social Studies, Business Management and Administration. The remainder are divided between Agriculture, Design, and other spheres of study.
Fachhochschulen serve applied research and development, but their levels of staffing and financial resources set limits to these activities. Research and development are mainly pursued with an eye to the immediate application and utilisation of scientific findings in everyday practice. That also produces useful information on the further development of teaching. Fachhochschulen are of particular importance too in the provision of technical and scientific advice for small and medium-sized firms in the region, and in the sphere of transfer of technology.
Professors at the Fachhochschulen can, if they so wish, work on research projects at universities or make use of the research facilities there if the Fachhochschule concerned is not equipped for that purpose. Their opportunities for research within a Fachhochschule can be improved by way of money from central funds for assisting research or by research contracts.

6. Representation of Universities, University Teachers, and Students

Unstructured meetings around the turn of the century and in the early 1900s, and a German Universities' Association set up in 1919 mainly to serve the interests of university teachers, were followed in 1949 by the establishment at Bad Godesberg of the West German Rectors' Conference (Westdeutsche Rektorenkonferenz – WRK) uniting the Rectors' Conferences set up in the three Western zones of occupation after the Second World War. This organisation is today a voluntary and autonomous federation of universities in the Federal Republic of Germany and Berlin (West). Its statutes distinguish between:

1) Universities, Technical Universities, etc, Comprehensive Universities, Colleges of Education with the right to grant doctorates
2) Colleges of Education in Baden-Württemberg
3) Fachhochschulen
4) Art Colleges, Music Colleges, Theological Colleges, Church Colleges
5) Other Colleges such as the Federal Army Universities.

The emphasis is on the universities in the first group whose members in the Rectors' Conference each have a vote. The second group has a total of 3 votes; the members of group 3 one vote for each of the Laender; and the members of groups 4 and 5 only one vote for each type of college.

Various types of college (Staatliche Fachhochschulen, Church Colleges, and Colleges of Art and Music) also have their own Rectors' Conferences for dealing with specific problems.

The West German Rectors' Conference forms the framework within which the member universities come together so as to discuss and resolve shared problems in the spheres of research, teaching, studies, and academic self-administration. It informs the public about the tasks, needs, and particular working conditions of the universities, and its recommendations to parliaments and governments contribute to decisions on educational and scientific policy. It works closely together on many issues with Federal and Laender Ministries and other educational organisations. It represents the member universities in international and supra-national organisations and institutions, promoting co-operation with rectors' conferences or similar bodies in other countries. It also maintains a comprehensive library on the development of higher education with particular reference to universities and scientific policy.

In the international sphere, the West German Rectors' Conference played an important part in the establishment of the Standing Conference of Rectors and Vice-Chancellors of the European Universities (CRE). It

supports the work of various other associations of European universities within the framework of the European Community and the Council of Europe, is involved in the university programmes of the OECD and UNESCO, and promotes relations with Eastern European universities.
Within the Federal Republic of Germany the Conference's views, based on informed judgement, have particular weight within discussion of university legislation, reform of studies, and promotion of university research and up-and-coming young scientists.
The work of the Conference is financed by the Federal and Laender authorities. The "Foundation for the Promotion of the West German Rectors' Conference" was set up to provide for financial requirements and act as the staff's employer.
The Association of University Teachers (Hochschulverband)[1], representing Professors and external lecturers, was set up in 1950, a year after the Conference. Around 60% of the full-time teachers at the universities belong to the Association, which now has almost 12,000 members. This organisation is financed from its members' contributions, and represents their views on university policy, and their legal and economic interests in state and society. It has also always shared a sense of responsibility for the universities' general well-being – whereby there may perhaps be fewer possibilities of conflict in the Federal Republic of Germany as compared with other countries. Most university teachers are civil servants, so the Association mainly has to represent their interests vis-à-vis the state.
More than half the academic staff at Fachhochschulen and those concerned with application-oriented courses at Comprehensive Universities belong to the Hochschullehrerbund, which represents the particular interests of teachers in this practical sphere. In its objectives, financing, and working methods, this organisation is similar to the Hochschulverband in its sphere. Ever since the establishment of the Fachhochschulen both Associations have worked together in many instances. The Hochschullehrerbund promotes the independent further development of the Fachhochschulen.
The University and Science Association in the German Civil Servants' Federation (Verband Hochschule und Wissenschaft im Deutschen Beamtenbund) looks after this vocational group's particular interests. The Education and Science Trade Union (Gewerkschaft Erziehung und Wissenschaft) in the German Trade Union Federation, the Federation for the Freedom of Science (Bund Freiheit der Wissenschaft), and the Federation of Democratic Scientists (Bund demokratischer Wissenschaftler) are concerned with broader issues in scientific and educational policy.

[1] since 1986 Deutscher Hochschulverband

The representation of students in individual universities varies in accordance with the University Law in the Land concerned. Student organisations involving obligatory membership and payments exist in nine of the Laender, representing students in general (Allgemeiner Studentenausschuß, AStA). In Baden-Württemberg and Bavaria no provision has been made for some years now for organised student bodies, which have been replaced by student representation whose election is not limited to a special organisation. Students are represented in all Laender by seats and votes in university committees. The United German Students' Organisation (Vereinigte Deutsche Studentenschaften – VDS) thus consists of student bodies from individual universities with the exception of those in Baden-Württemberg and Bavaria. There are also a large number of groupings concerned with university policy, politics, religious allegiance, the arts, social issues, and internationalism, and also student fraternities which are sometimes organised on a national basis.

University bodies looking after the students' social needs at individual universities are represented at the national level in the German Student Welfare Organisation at Bonn (Deutsches Studentenwerk e. V.).

Representation of university teachers and, even more so, of students is more diffuse than that of the universities where the West German Rectors' Conference acts as central organisation and spokesman. This situation corresponds to the nature of political discussion in the universities which, especially in the past decade, has been particularly concerned with general political and social issues rather than just university and research policy.

Table 5

Higher Education in the Federal Republic of Germany
– Institutions, Staffing, and Students –

For details see tables I. 1–3 in the Appendix.

Institution	Staff[2]		German and foreign students[3]
	total	Academic staff	
93 Universities	281,938	108,456	1,015,100
26 Colleges of Art and Music	5,769	4,685	21,700
122 Fachhochschulen[1]	31,585	21,425	301,300

[1] Including civil service facilities
[2] Staff figures for 1984
[3] Winter semester 1985/86 (to nearest 100)

Sources: Federal Ministry of Education and Science: Reihe Grund- und Strukturdaten, Bonn
Federal Statistics Office: Personal an Hochschulen 1984 (Bildung und Kultur. Fachserie 11, Reihe 4.4, Mainz 1986).

II. *Scientific Academies and Supporting Bodies in Basic and Applied Research*

1. The Academies of Science

These academies, which are usually organised in two sections devoted to mathematics/natural sciences and history/philosophy, are characterised by their dual nature as scholarly societies and agencies of large-scale and long-term (often extending beyond the life-span of a single researcher) scientific tasks, primarily in the sphere of basic research. They differ from universities in only serving research, not teaching, and from research institutions in that they do not restrict their work to a specific subject or even a limited range of subjects.

The first Academies of the Sciences in German-speaking areas – leaving aside the "German Academy of Natural Scientists" set up at Schweinfurt in 1652, which later became the "Leopoldina" at Halle – were established in the 18th century. These included Göttingen's Academy of Sciences in

1751, and the Bavarian Academy of Sciences in Munich (1759). The three other Academies in the Federal Republic of Germany were founded in the 20th century: the Heidelberg Academy of Sciences (1909), the Academy of Sciences and Literature at Mainz (1949), and the Rhenish-Westphalian Academy of Sciences at Düsseldorf (1970).

The early academies were established by local rulers, although the initiative of individual scholars, such as Gottfried Wilhelm Leibniz in Berlin (1700), sometimes also played a part. The continued existence of the Academies was guaranteed by the state – in contrast to the other scientific societies. Their task was to foster scholarship in general except for the activity of teaching which was the task of the universities. The older Academies thus established laboratories and institutes for scientific research during the early days of their existence, facilities that the universities did not then have. This development was intensified in Eastern and Central Europe where the Academies are today responsible for extensive research institutes. Growth proceeded in a different direction in Germany in the first half of this century and later in the Federal Republic. The scientific universities increasingly took on the task of research in the natural sciences, and the great non-university state institutes and the Kaiser Wilhelm Society (1911), which later became the Max Planck Society, were not set up under the auspices of the Academies. Today the Academies are primarily indispensable as sources of support for extensive editions of works and large-scale dictionaries.

Göttingen's Academy of Sciences is, for instance, working on a large Goethe Concordance (together with the Heidelberg Academy), the Thesaurus Linguae Graecae (the most comprehensive dictionary of Classical Greek), and investigations into Buddhist literature. It is also preparing an edition of the works of Immanual Kant, the philosopher, and is researching into geomorphological processes such as natural catastrophes in the world's landscape and altitude zones.

The Bavarian Academy of Sciences is occupied with a Thesaurus Linguae Latinae, Dictionaries of Mediaeval Latin and Tibetan, and with preparing editions of the works of astronomer Johannes Kepler and philosophers Johannes Gottlieb Fichte and Friedrich Wilhelm Schelling. In the natural sciences, the Bavarian Academy has staff conducting research into such matters as glaciers and satellite geodesy. It is also responsible for the Leibniz research centre and the central institute for research into low temperatures.

Apart from the Goethe Concordance, the Heidelberg Academy is also involved in a Dictionary of Old Gascon, publishes such works as an illustrated lexicon of Classical Mythology and Philipp Melanchthon's Letters,

and maintains a geo-medical research centre concerned with the World Atlas of Epidemics.

The Mainz Academy of Sciences and Literature, established after the Second World War, is less tied down to a single place than the other Academies, and has a large number of working-bases even in other Laender. It is involved in terminological lexica (Historical Dictionary of Philosophy, Dictionary of Musical Terminology), concise dictionaries (a Palatinate and a Prussian Dictionary), lexica of foreign languages (Dictionary of Contemporary Russian, Lessico Etimologico Italiano), projects in history and art history (Regesta Imperii and Corpus Vitrearum Medii Aevi), and research into ageing, the fundaments of biology, and terrestrial palaeo-climatology.

The youngest of the Academies, the Düsseldorf-based Rhenish-Westphalian Academy of Sciences, publishes such works as an Encyclopaedia, the Yearbook of Classical Antiquity and Christianity, a commented collection of Papyrus Documents, and the works of Hegel. Unlike other academies, it also participates in another special function, helping allocate research funds from the Land of North Rhine-Westphalia.

The academies receive money for their basic needs and part of their project funds from the Laender. More extensive projects for the most part receive assistance within the framework of joint Federal-Laender financing (P 51). This programme and other joint enterprises are co-ordinated by the Conference of Academies of Science in the Federal Republic of Germany. The Academies are members of the Union Académique Internationale. They intensively cultivate relations with academies and scholarly societies in other countries, have a large number of foreign scholars among their corresponding members, and participate in the international exchange of scientific publications. They make available their research findings in papers and their own series of publications.

2. Max Planck Society for Promotion of the Sciences – Max-Planck-Gesellschaft

The Max Planck Society (Max-Planck-Gesellschaft zur Förderung der Wissenschaften – MPG) provides support for over 55 institutes and research groups spread over the whole of the Federal Republic of Germany inclusive of West Berlin, and also takes in the Bibliotheca Hertziana in Rome and the Max Planck Institute of Psycholinguistics at Nijmegen in Holland. Its legal status is that of a private non-profit-making organisation despite most of its finance coming from the state.

The Kaiser Wilhelm Society for Promotion of the Sciences was set up in Berlin in 1911 as the result of preparatory work by Friedrich Althoff, the Prussian university administrator, and Adolf von Harnack, the theologian. The Society's objective was to establish research institutes (with special emphasis on the natural sciences) where leading scientists, freed from the obligation to teach, could devote themselves exclusively to research. The Society was initially financed from private funds so that its complete independence was assured. It thus had complete freedom of decision over its scientific objectives and tasks. This freedom has been preserved up to the present day even though over the course of time there has been a steady increase in state involvement in financing so that private funds now only play a minor part.

In the year of the Society's establishment the first institute was set up in Berlin, the Institute of Chemistry where Otto Hahn and Lise Meitner made the discoveries leading to uranium fission. Other institutes were established in rapid succession, over 20 of them within the first 10 years, initially mainly in the sphere of the natural sciences and medicine but soon also in the humanities as for instance in the case of the Bibliotheca Hertziana, endowed in Rome by Henriette Hertz for research into the history of Italian art. The foundation of the Kaiser Wilhelm Society thus became – as the Science Council (P 50ff) was later to say – "a momentous step towards the expansion and intensification of German research potential". The Society survived the two World Wars, the economic crisis of the 1930s, and the time of National Socialism. In February 1948 the Max Planck Society for Promotion of the Sciences was set up with the task of continuing the work of the Kaiser Wilhelm Institutes.

The size and structure of individual Max Planck Institutes vary considerably, depending on the tasks and the historical development involved. Some of these institutes are large research centres with a managerial board, a staff of several hundred, and a considerable number of scientifically independent departments. There are also smaller institutes with just a few staff members. The Max Planck Institutes are mainly devoted to fundamental research with an emphasis on new spheres of activity whose content, scale, and structure mean that they are not so suitable, or ready, for researching at university. The main areas of interest are the bio-medical sphere inclusive of behavioural research and molecular biology, astrophysics, general physics, chemistry, mathematics, research into such materials as iron, coal, and metal, solid-state and plasma physics, meteorology, aeronomy, and research into areas of near space. There is also a focus on specific areas of the social sciences and the humanities such as history, foreign and international civil and penal law, the history of

European law, public and international law in other countries, and research into education. Mention should also be made of the more recent establishment of an Institute of Polymer Research and an Institute for Social Research.
In recent years the Max Planck Society has devoted particular efforts towards intensifying research in clinical medicine to which considerable attention was already being paid. That has resulted in five research groups having been established to date, concerned with reproduction, blood clotting and thrombosis, multiple sclerosis, gastro-intestinal endocrinology, and biological regulation of host-tumour interaction. These groups are working closely together with local university clinics.
A staff of over 10,000 work for the Max Planck Society, which is financed in accordance with the Outline Agreement on Assistance for Research from the Federal and Laender Authorities (P 47). These staff figures include some 2,400 guest scientists from Germany and abroad each year, a demonstration of intensive co-operation with universities and, even more, research institutes in foreign countries. The Max Planck Society and its institutes are today among the leading centres of non-university research in the Federal Republic of Germany. The voice of the Max Planck Society also has great weight with regard to scientific policy.

3. Fraunhofer Society for Promotion of Applied Research – Fraunhofer-Gesellschaft (FhG)

Joseph Fraunhofer, a glass-grinder and physicist who lived in Munich in the late 18th and early 19th centuries, produced astronomical lenses of a hitherto unknown quality, thus gathering new physical information about the spectral lines of the sun. The Fraunhofer Society (Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung) named after him was founded in 1949 to pursue research and development in the spheres of the natural sciences and engineering on behalf of industry and the state. The 1973 decision in favour of further expansion also involved the introduction of an interesting new model of financing research. Here the federal and Laender authorities grant the Society the basic finance for a project, but the actual payment depends on the amount of money earned by the Society from contract research. This model is therefore intended to stimulate increased contract research on behalf of industry and the state authorities.
Today the research and development carried out by the Society mainly covers micro-electronics, information technology, automation, produc-

tion engineering, behaviour of materials and components, process engineering, energy and construction, environmental research, and technical and economic studies. A staff of around 3,000 work in 33 institutes and branches of the Society. Six of the Institutes mainly serve military research, and are therefore separately financed from federal funds.
Its experience and success in research and development have resulted in the Fraunhofer Society becoming an important catalyst, above and beyond its own activities, in the process of transfer of technology from research to industry. The Society is thus concerned with the development of aids to decision-making in public planning, particularly with regard to evaluation of lines of technological development and to decisions on the introduction of new technologies. It is seeking new ways of speeding up the transfer of scientific and technical findings from universities and other research centres, thus increasing the rate of innovation. Small and medium-sized firms benefit particularly much from co-operation with the Fraunhofer Society.

III. *National Research Centres – Großforschungseinrichtungen*

There are 13 national research centres in the Federal Republic of Germany. These developed over the past three decades, and employ a total of around 19,000 people including some 7,000 scientists. 90% of the money involved – around 2.2 milliard DM – is normally provided by the federal authorities from the budget of the Federal Ministry of Research and Technology, and the other 10% by the Laender. That is supplemented by considerable assistance for individual projects.
As Table 6 (P 38) shows, the first national research centres were established in the sphere of nuclear research and the development of nuclear technology. Basic research in physics utilising special large-scale equipment then followed later. The third stage consisted of establishment of facilities for space research, data- processing, research in biology and medicine, and, most recently, polar and oceanographic research.
A transformation in function is often concealed behind the names of these research set-ups. Progress in, for instance, a number of spheres of nuclear technology has been so great that industry can carry on developments on its own while new emphases of research have been established in reactor safety and the fuel cycle. New spheres of application have been added to data-processing. In medical and biological research, protection of the environment, and ensuring supplies of raw materials and energy on economic terms, there are constantly new tasks which can only be mas-

tered by way of major research centres because of their importance for state and society, their complexity, and the amount of equipment and number of staff required.

New centres cannot always be established for such tasks, which must then – apart from a few exceptions such as polar research – be provided for in existing set-ups. The major research centres here make available their experience as project-managers in the co-ordination of researchers from various institutions. They also, time and again, devote themselves to new tasks and methods, which demand considerable effort on the part of the staff involved.

The task of constant diversification demands and favours co-operation between the organisations involved in major spheres of research, and also co-operation with the universities, other research bodies, and industry, which can in turn derive benefit from such a partnership.

Their size, structure, and interesting sphere of activities mean that major research centres are particularly suited to fostering international co-operation in research and technology. Many projects within large-scale research cannot anyway be realised within the confines of a single country, and in some cases a division of labour is helpful. The European Organisation for Nuclear Resarch (CERN), the European Space Agency (ESA), the European Organisation for Astronomical Research in the Southern Hemisphere (ESO), the European Laboratory for Molecular Biology (EMBL) at Heidelberg, and the Centre for Medium-Range Weather Forecasting at Reading are examples of international organisation of such large-scale research (P 93).

Almost all of the national research centres in the Federal Republic of Germany welcome scientists from all over the world as their guests.

In France and Great Britain such set-ups are normally state bodies, but in the Federal Republic these organisations are legally independent, usually taking the form of a limited company. The government authorities act by more general regulations. They utilise the supervisory boards for laying down the general objectives of research and the overall extent of financial support, establishing priorities, and co-ordinating the work of the individual institutions. They also assist and co-ordinate international co-operation, and of course watch over the economical use of the considerable public funds involved. Within this framework though, the research institutions are independent and responsible for their own activities. The judgement of representatives of science and technology is unquestioned as far as scientific and technical issues are concerned.

The centres are linked in an association (Arbeitsgemeinschaft der Großforschungseinrichtungen – Association of National Research Centres)

based in Bonn, which is concerned with co-ordination, exchanges of experience and information, and representation of shared interests.
There are two other set-ups that are not quite the same as the national research centres but operate along similar lines: the Heinrich Hertz Institute for Communications Technology in Berlin (West) that has already been in existence for over 50 years, and the Berlin Science Centre for Social Research established in 1969.

Table 6

Overview of national research centres

Centre		Estab.
Kernforschungszentrum Karlsruhe GmbH	KfK	1956
Kernforschungsanlage Julich GmbH	KFA	1956
Gesellschaft für Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Hamburg	GKSS	1956
Hahn-Meitner-Institut für Kernforschung mbH, Berlin	HMI	1957
Stiftung Deutsches Elektronen-Synchrotron, Hamburg	DESY	1959
Max-Planck-Institut für Plasmaphysik, Garching	IPP	1960
Gesellschaft für Strahlen- und Umweltforschung mbH, Neuherberg	GSF	1964
Stiftung Deutsches Krebsforschungszentrum, Heidelberg	DKFZ	1964
Gesellschaft für Schwerionenforschung mbH, Darmstadt	GSI	1969
Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt e. V., Porz	DFVLR	1968
Gesellschaft für Mathematik und Datenverarbeitung mbH, Birlinghoven	GMD	1968

Source of finance	Staff 1985	Total Expenditure 1985 (target) Million DM	Main emphases
Federal Government Baden-Württemberg	3,235	498	Nuclear Technology (Fast Breeder) and Research
Federal Government North Rhine-Westphalia	3,398	412	Nuclear Technology (High Temperature Reactors) and Research
Federal Government Bremen, Hamburg, Lower Saxony	547	86	Nuclear Technology (Marine reactors), NS "Otto Hahn"
Federal Government Berlin	505	92	Nuclear Research (Chemistry, Physics)
Federal Government Hamburg	1,033	237	Nuclear Research (High Energy Physics)
Federal Government Bavaria	935	88	Nuclear Research (Plasma Fusion)
Federal Government	1,115	123	Biology, Medicine, Environmental Research
Federal Government Baden-Württemberg	689	97	Cancer Research
Federal Government Hesse	457	88	Nuclear Research (Physics, Chemistry)
Federal Government Baden-Württemberg, Bavaria, Lower Saxony, North Rhine-Westphalia	2,753	311	Aero-Space Technical Research
Federal Government North Rhine-Westphalia	580	68	Mathematics and Data-Processing

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Centre		Estab.
Gesellschaft für Biotechnologische Forschung mbH. Stöckheim	GBF	1968
Alfred-Wegener-Institut für Polar- und Meeresforschung. Bremerhaven	AWI	1980

Source: Federal Research Report 1984. Faktenbericht 1986 zum Bundesbericht Forschung.

IV. *Federal and Laender Research Facilities*

Alongside the universities, the institutes of the Max Planck Society and the Fraunhofer Society, and the national research centres, there exist a relatively large number of individual institutes and associations which are directly supported by the state. A distinction can be made between three groups here.

Firstly institutes serving departmental research, bodies subordinate to individual federal or Laender ministries. These organisations carry out the scholarly work necessary for solution of general public functions or specifically governmental tasks. The history of such institutions started in the 19th century when the boom in the natural sciences and engineering, and their mounting significance for business and culture, increasingly confronted governments and administrations with scientific and technical problems. Early examples were provided by the Imperial Health Office of the German Reich (1876) and the Imperial Office of Physics and Technology (1887). The latter was established under the direction of Hermann von Helmholtz on the initiative of Werner von Siemens, and later became the model for the foundation of similar foreign institutes as at London in 1900 and at Washington in 1901.

Today there are 42 such institutes and offices within the sphere of competence of the Federal Ministries alone. The largest group is constituted by the 13 research bodies within the area of activity covered by the Federal Ministry of Food, Agriculture, and Forests. The Federal Office for Agricultural Research at Brunswick-Völkenrode is itself divided into no

Source of finance	Staff 1985	Total Expenditure 1985 (target) Million (DM)	Main emphases
Federal Government Lower Saxony	271	36	Bio-Technological Research and Development
Federal Government	83	65	Polar and Oceanographic Research
total:	15,601	2,201	

fewer than 15 separate institutes covering different aspects of agricultural production and husbandry, and the Federal Office of Biological Agriculture and Forestry, which is concerned with plant protection, is based at Brunswick, Berlin, and seven other places, and comprises a total of 15 institutes and departments. Among the other large institutes are the Federal Health Office, the Federal Office for the Testing of Materials, the Federal Office for the Environment, and the Federal Vocational Training Office (all in Berlin [West]), the already mentioned Office for Physics and Technology in Brunswick and Berlin (West), the German Weather Service at Offenbach, the Federal Office for the Earth Sciences and Raw Materials at Hanover, the Federal Roads Office at Bergisch-Gladbach, the German Hydrographic Institute at Hamburg, and the Federal Office for Protection at Work and Research into Accidents at Dortmund.

The Laender also have similar research groups and test laboratories, mainly covering agriculture, geology and soil research, and environmental issues.

Another group of around 50 institutes is jointly financed by the federal authorities and single Laender or all of the Laender together. Here too there are a number of institutes, such as the big institutes of economic research, that make important contributions to public services or government activities. These institutes also include in their number organisations that extend into the sphere of the humanities, such as the Institute of Contemporary History in Munich and the Mannheim-based Institute for the German Language. A number of museums such as the Roman-Germanic Central Museum at Mainz, the Germanic National Museum at Nurem-

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berg, and the German Museum in Munich are also financed in this way (P 45). A number of institutes are mainly active abroad. The largest of these is the German Archaeological Institute with its head office in Berlin (West). This originated in an "Istituto di Corrispondenza Archeologica" set up in 1829 by a group of friends – scholars, artists, and diplomats. In 1837 the organisation's head office moved from Rome, where there is still an institute, to Berlin. Another branch of the institute was established at Athens in 1874. Today the Institute consists of the Berlin head office, the Roman-Germanic Commission at Frankfurt (and an office at Ingolstadt), the Munich-based Commission for Ancient History and Epigraphy, the Bonn-based Commission for General and Comparative Archaeology, branches at Rome, Athens, Cairo, Istanbul (also an Ankara office), Madrid (also a Lisbon office), Baghdad, and Teheran, and out-stations at Sanaa and Damascus. The Institute organises excavations, expeditions, and other research projects in Germany and abroad, and also provides information and documentation in special libraries and phototèques open without restriction to international science. The Institute also awards research fellowships to German and foreign scientists.

Among the other Federal German research facilities in other countries are the German Historical Institutes in Paris, Rome, and London, the Institute of Art History at Florence, the German Oriental Society's Orient Institute at Beirut, and the Max Planck Society's Bibliotheca Hertziana at Rome. All these institutions serve both the activities of German scholars in those countries and, to an even greater extent, co-operation with scholars in the host countries and assistance for foreign scholars wanting to pursue research into history and art. The Wissenschaftskolleg zu Berlin – Institute of Advanced Study – also serves scholarly communication across the barriers of specialisations and nations. This is intended to provide up to 40 leading scholars with a chance of devoting a year to concentrated pursuit of their particular interests. The Wissenschaftskolleg is supported by the Ernst Reuter Foundation in Berlin (West), and grants for visiting scholars are provided by the Federal Ministry of Research and Technology.

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V. *Private Research Institutes*

Alongside the research set-ups financed by the state or largely from public funds and the research facilities within industry and individual firms (P 68), there are a large number of private institutes which mainly finance themselves by way of contract research, other sources of backing for individual projects, and income from membership subscriptions. The institutes supported by small and medium-sized industrial firms and research associations constitute the largest group in this sector. Around 90 % of the associations have formed the Cologne-based Union of Industrial Research Associations (Arbeitsgemeinschaft Industrieller Forschungsvereinigungen – AIF). The institutes involved are concerned with research projects whose findings are of interest for the widest possible range of firms within that area. For competitive reasons, this work generally entails preliminary stages of the actual development, which must then be pursued by the firms themselves.

Private research facilities also include institutes for market and public opinion research, organisations which specialise in forecasts and developmental projections, and bodies for empirical social research. Other institutes receive backing from scientific societies and other groupings.

Many of these institutes work in close conjunction with universities, and some of them are also headed by university teachers. That often receives expression in the designation "university-affiliated institute".

VI. *Libraries, Museums, and Centres for Specialised Information*

1. Scientific Libraries

The scientific libraries with over 100 million volumes are the most important element in a well-developed public library system, complemented by private initiative, in the Federal Republic of Germany. Their main task is to collect and make books available for research, teaching, training, cultural purposes, and vocational needs. They also make an important contribution to general provision of books and information. The big university libraries basically collect books from all the more important spheres of knowledge. There are also subject or specialised libraries, which largely limit their collections to a specific sphere. These include the libraries of research organisations, public authorities, associations,

churches, and industry as well as the many faculty and institute libraries in universities. A number of libraries are jointly financed by the federal and Laender authorities because of their national importance: the Library of Technical Information at Hanover's Technical University, the Central Medical Library at Cologne, and the Central Library for Economic Sciences and the Economics Archive at Kiel University's Institute of World Economics. The German Library Institute in Berlin (West), concerned with planning, organising, and developing the library system in general, is also jointly financed by the federal and Laender authorities.
The scientific libraries receive additional assistance from the German Research Society (DFG) (P 57). The DFG provides support for special collections in certain general libraries, making funds available for the acquisition of specialised works in other languages. Help is also given to efficient special libraries, and money is available too for work on extensive catalogues, and for a special programme devoted to the cataloguing of Western manuscripts. The DFG also assists the making accessible of the contents of archives, and the preservation and filming of historically valuable newspapers. Assistance is given too for a series of research projects devoted to improving conditions in libraries, and initial help is often provided towards pilot schemes involving new technical and organisational developments. In the sphere of international exchanges of written works, the German Research Society has links with foreign centres for such activities, and arranges the transportation of in-coming and outgoing deliveries. Its own exchange facilities with some 1,200 institutions in over 80 countries are utilised to procure publications that cannot be reliably acquired through commercial channels.

2. Museums

There are some 2,000 museums in the Federal Republic of Germany, and a number also fulfil scholarly functions. As scholarly institutes, museums which are generally subdivided into institutions concerned with the exact natural sciences, natural history, the history of culture, and art, are mainly concerned with cataloguing, documenting, and answering questions about the objects in their care. They make accessible what cultural artefacts have to express, and plan and implement measures for preservation of the natural state of the environment, works created by man, and the man-made environment.
Museums are generally financed by the Laender, local authorities, or sometimes by foundations and private organisations. As in the case of

libraries though, some museums receive support from both the federal and Laender authorities as being of national importance as scientific institutes. That applies to the German Museum in Munich, the Germanic National Museum in Nuremberg, the Roman-Germanic Central Museum in Mainz, and a number of special museums such as the Mining Museum at Bochum, the German Shipping Museum at Bremerhaven, and the Institute of Zoological Research and the Alexander Koenig Museum in Bonn. The federal and Laender authorities have also concluded a special agreement on the financing of the Prussian Cultural Foundation (Stiftung Preußischer Kulturbesitz) in Berlin (West) with 14 museums, the State Library, and the secret archives of the former state of Prussia. Since 1979 the Foundation has also had an institute of museum studies at its disposal, carrying out fundamental research in this sphere.

3. Centres for Specialised Information

The Federal Government, working together with the Laender, assists the establishment and expansion of information banks on the basis of the 1985 – 88 programme for specialised information. The objective is to make such specialised information quickly and effectively available to scholarship, business, the state, and society, thereby accelerating both advances in knowledge and practical application of scientific discoveries.

Over the past ten years in the Federal Republic of Germany a number of producers and suppliers of electronically stored specialised information have established themselves. Among the most important are

- Specialised Information Centre for Chemistry GmbH, Berlin (West)
- Specialised Information Centre for Energy, Physics and Mathematics GmbH, Karlsruhe
- Specialised Information Centre for Technology, Frankfurt
- Planning and Construction Information Centre, Stuttgart
- German Institute for Medical Documentation and Information, Cologne
- Central Office for Agricultural Information and Documentation, Bonn
- JURIS Legal Information System, Bonn

These establishments work hand-in-hand with libraries in procuring specialised books – and particularly with the Library of Technical Information in Hanover (TIB).

C Promotion of Research and Assistance for Young Scientists

I. *Co-operation between Government, Science, and Industry in the Promotion of Research*

A diverse structure of support and finance for scientific facilities has been demonstrated in the preceding sections. The Laender substantially finance the largely autonomous universities but the federal authorities do make a considerable contribution towards the construction and equipping of these institutions. The academies of science are also mainly supported by the Laender but shared activities are jointly financed by the Laender and federal authorities. The Max Planck Society, which is scientifically and legally autonomous, is largely financed by the Federal Government and the Laender. The Fraunhofer Society, which is also independent, receives its basic finance from the public authorities in accordance with the number of contracts for research and development the organisation manages to attract. The national research centres are mainly financed from federal sources and to a lesser extent by the Laender. They are organised in accordance with civil law, and governmental influence is limited to very general regulation. Individual research institutes receive support from either the federal or Laender authorities or both.

A similar diversity is to be found in the assistance given to research and to young scientists whereby the overall picture is further enriched by the activities of industry. Examples will be given in the sections that follow of the division of functions and of the co-operation in research programmes and in organisations that promote research. First, however, attention will be devoted to two bodies serving to exemplify how the Federal Republic of Germany attempts to solve the financial, structural, and material problems and tasks involved in assisting research.

1. The Federal-Laender Commission for Educational Planning and Promotion of Research

– Co-operation between the federal and Laender authorities

In a federally-structured state it is exceptionally important to find suitable forms of co-operation between regional authorities. Alongside its development and co-ordination of basic principles within educational planning and nationwide recommendations on the furtherance of research, the

Federal-Laender Commission for Educational Planning and Promotion of Research (Bund-Länder-Kommission für Bildungsplanung und Forschungsförderung – BLK) serves this function in a variety of ways:

- in research policy decisions with regard to the initiation or termination of joint financing of an institute or institution
- in preparing for and reaching agreement on current financial decisions in joint promotion of research
- in the co-ordination of information on issues of research policy between the Federal and Laender authorities.

This Commission was originally established in 1970 as the Federal-Laender Commission for Educational Planning. After the federal and the Laender governments in November 1975 concluded an outline agreement on joint promotion of research, the Commission's functions were extended and its name was expanded in 1976. Both of these developments were based on article 91 b in the Federal Republic's constitution, the Basic Law, according to which the federal and Laender authorities can conclude agreements on educational planning and on the promotion of facilities and projects within the sphere of scientific research of supra-regional importance (P 14).

The Outline Agreement on the Promotion of Research lays down that such joint assistance extends to

- the German Research Society and special collaborative programmes (P 57 and P 25)
- National research centres (P 35)
- the Max Planck Society (P 32)
- the Fraunhofer Society (P 34)
- a number of autonomous research institutions and organisations as well as service facilities, provided that these are of supra-regional importance and serve national interests of science policy, and that the costs involved exceed a certain level (so-called Blue List Institutes, P 41)
- special research projects of supra-regional importance serving national interests in scientific policy, including the programme jointly pursued by the Academies (P 30).

Table 7

Joint Federal-Laender Assistance for Research Institutions (in million DM)

Facilities	1986		
	total	Federal	Laender
German Research Society			
a) General assistance	650.0	325.9	324.1
b) Special collaborative programmes	312.1	234.1	78.0
c) Heisenberg-Programme	15.0	7.5	7.5
d) Leibniz-Programme for Highly-Qualified Research	8.0	6.0	2.0
National research centres	2414.5	2156.7	257.8
Max Planck Society	814.0	407.0	407.0
Fraunhofer Society[1]	171.8	131.7	40.1
Other research facilities[2]	432.1	229.8	202.3
Academies programme	29.3	14.7	14.6
total	4847.1	3513.5	1333.6

[1] exclusive of defense-related research which is not part of Federal-Laender financing.
[2] the Blue List Institutes.

Source: Federal-Laender Commission for Educational Planning and Promotion of Research: BLK-Bericht 1985.

Joint assistance for research extends over a considerable range of such activities in the Federal Republic of Germany. This does not, however, include the normal basic finance for the universities, federal and Laender facilities and programmes associated with particular Ministries, and industrial research.

The Federal-Laender Commission for Educational Planning and Promotion of Research first drew up individual strategies for implementation of research, laying down, for instance, which individual institutes fulfilled the preconditions for joint financing or which projects could be included in the Academies' programme. Above all though, the Commission pre-

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pares detailed plans for the financing of organisations and facilities receiving assistance, and presents the heads of the federal and Laender governments with suggestions regarding approval of budgets for the institutions. It is also charged with the additional task of dealing with basic issues in the specialised information systems that are to be developed in the Federal Republic for the various spheres of expertise.
For its deliberations on promotion of research, the Commission includes seven representatives from the Federal Government (from the Ministries concerned with research and the Federal Ministry of Finance) and two representatives from each of the eleven Land Governments (again from the Ministries concerned with education, science, and finance). The federal and Laender authorities each have the same number of votes though with one vote each for the Laender and a total of eleven votes for the representatives of the Federal Government. Representatives of science do not have a vote in the Commission but the chairman and secretary-general of the Science Council (P 50) take part in its meetings, and consultation with the research facilities and organisations involved does of course take place in the committee stage. The Commission's recommendations and the decisions then taken by the heads of the federal and Laender governments are subject to the proviso that the German Federal Parliament and the Land parliaments have the final word in all financial decisions. The Commission's preparatory work is nevertheless not just a matter of functional content. The Commission is also a place for discussion of research policy, and for co-ordination on the one hand between the federal and Laender authorities, and, on the other, between the Ministries concerned with science and university affairs and the Ministries of Finance.

2. The Standing Conference of Laender Ministers of Education (KMK)

The distribution of powers within the Federal Republic's structure of authority means that co-operation between the Laender is of great importance alongside joint Federal-Laender endeavours. The most important instrument of Laender co-operation in the sphere of educational, scientific, and cultural policy is the Standing Conference of Laender Ministers of Education (Ständige Konferenz der Kultusminister der Länder in der Bundesrepublik Deutschland – KMK). With regard to scientific policy the Conference mainly serves the co-ordination of all matters falling within Laender competence and of Laender views on general issues in scholarly policy and financing with an emphasis on the university sphere. Joint

Laender financing of individual research facilities of more than local significance is also regulated by way of the Conference.

The Standing Conference of Laender Ministers of Education was established in 1948 as an association of Ministers and Senators from the Federal Laender and Berlin (West) responsible for education and training, scholarship and research, and art and culture. The Conference meets as a ministerial plenary session and as a gathering of leading civil servants. Each Land has only one vote, even though it may be represented by more than one minister. Resolutions only take effect if unanimously voted by the Conference, which is concerned with agreements and recommendations within its sphere of competence. The Conference has established permanent committees and commissions, staffed by appropriately qualified civil servants from Laender ministries, for the preparation of resolutions and exchanges of information between the administrations concerned. The university commission is the most important of these bodies, dealing with scholarly requirements. The Conference of Ministers of Education also has a permanent secretariat in Bonn, established on the basis of an agreement between the Laender.

3. The Science Council

– Co-operation between federal and Laender Governments, science, and representatives of public life

The Science Council (Wissenschaftsrat), which has its headquarters in Berlin (West) (where plenary sessions also take place) and an office in Cologne, was established in 1957 on the basic of an agreement between the federal and Laender authorities. It consists of a scientific commission and an administrative commission. Resolutions require a two-thirds majority of the general assembly.

The twenty-two members of the scientific commission are appointed by the Federal President – sixteen on the joint suggestion of the German Research Society, the Max Planck Society, the West German Rectors' Conference, and the Association of National Research Centres, and six as representatives of public life (from, for instance, industry or the trade unions) on the joint recommendation of the Federal and the Laender Governments.

The seventeen members of the administrative commission consist of six delegates of the Federal Government and one delegate for each of the Laender Governments. The federal representatives have a total of eleven

votes, and the delegates from the eleven Laender each have one vote, thus ensuring balance.

The agreement on establishment of the Science Council provides for the drawing up of recommendations on the subject-matter and the structural development of universities, science, and research in accordance with the demands of social, cultural, and economic life. These recommendations are also accompanied by reflections on their realisation and on the quantitive and financial implications. The Science Council also has the task of providing evaluations of developments in the spheres of university, science, and research at the request of a Land, the federal authorities, the Federal-Laender Commission for Educational Planning and Promotion of Research, or the Standing Conference of Laender Ministers of Education. Alongside its other tasks the Science Council is called upon in the law for the promotion of university building to draw up annual recommendations for the plan covering university expansion and new building.

The recommendations put forward by the Science Council are first separately considered by the scientific and administrative commissions, and then put before the general assembly where two thirds of the votes are necessary for approval.

A number of representatives of the one commission are always present for meetings of the other and vice-versa, and representatives of science, the federal and Laender authorities, and public life also work together in the committees. This close co-operation, which characterises the work of the Science Council as a whole, has resulted in its recommendations combining what in scientists' view is necessary with what is financially and politically realisable. The Council's recommendations thus carry exceptional weight even if they cannot be legally binding on governments and parliaments.

The 20th anniversary of the Science Council in 1977 was marked by a stock-taking of the organisation's work, and this survey was repeated five years later in 1982 on the occasion of its 25th anniversary. Its first important recommendations were devoted in 1960 to expansion of the universities, giving impetus and direction to reconstruction and development after the Second World War. In 1964 there followed recommendations on improvement of scientific libraries, and in 1965 on development of non-university research institutions, the academies of science, the museums, and scientific collections. In the years that followed there were comprehensive recommendations on further expansion of universities, on the organisation, planning, and promotion of research, on the situation and functions of Fachhochschulen, and on competition in the German university system.

The Science Council has regularly made clear its views on the project-planning and financial programme of the German Research Society. The special collaborative programme was a Council initiative, and it issues annual recommendations on the adoption of new special collaborative programmes and on the total amounts of money involved. More extensive recommendations have been devoted to the development of individual aspects of medicine and agriculture. The views of the Science Council are usually sought before a non-university institute is set up, and the list of research institutes jointly financed by the federal and Laender authorities is scrutinised on the basis of an assessment by the Council. Where gaps become apparent in research, the Science Council seeks ways of assisting such areas – as, for instance, in polymer research and empirical social research.

The recommendations of the Science Council demand a great amount of preparation. The Council is not just a body carrying great weight in the sphere of science policy. It is also the place where the material necessary for preparing the way for decisions is compiled, gathered, and assessed with the greatest care, and where – as in the Federal-Laender Commission for Educational Planning and Promotion of Research, and in the other research organisations – co-operation between a qualified staff and the members of the commissions and committees has been so successful.

II. *Federal Programmes for Research and Technology*

Every four years the Federal Government presents Parliament with a report on objectives, emphases, and action within its research policy.

The seventh such report[1] summarised the objectives of federal policy in research and technology as follows:

1. Extension and consolidation of the state of scientific knowledge
2. Preservation of natural resources and the environment, thereby contributing to humanly acceptable living and working conditions.
3. Intensification of industry's productivity and competitiveness

Table 8 co-ordinates these objectives and the main emphases of assistance, providing an idea of the magnitude of finance involved.

Extension of scientific knowledge, the first objective, is mainly served by assistance for basic research as described in previous sections. This chiefly involves Bonn's financial contributions to the German Research Society, the Max Planck Society, and the national research centres, several of

[1] Cf. Federal Research Report 1984

which largely pursue fundamental research. The promotion of international scientific co-operation does, however, also serve the objective of joint endeavours towards consolidation of understanding of interrelationships within nature and human co-existence.

The other two objectives involve the application of scientific knowledge and research findings. The Federal Government's first large-scale programmes were set up for nuclear research and technical developments in this sphere, for space research, data-processing, and marine research. The main emphasis was on technical and economic aspects. The number of programmes increased during the Seventies, and the range of tasks extended. At the same time the objectives of research policy have been very much broadened with a greater emphasis on general social aspects. Initiatives in that direction also came from the OECD in 1970.

From then on, people in the Federal Republic of Germany and other countries increasingly comprehended policy for research and technology as an instrument for creating better living conditions. New technical programmes were thus also accompanied by concentration on research in the spheres of health, nutrition, environmental planning, and humanising the world of work. The seventh Federal Research Report, however, puts the emphasis on support for individual initiative with the state keeping a low profile, particularly with regard to specifying the tasks involved. The intention is that public funds will only be employed where the state is directly responsible for their use, and where research and development require special support for overriding social or economic reasons. The 1984 Research Report views the state's crucial function as being to create a supportive infrastructure and a climate favouring and challenging peak achievements.

Most of the Federal Government's research and development programmes – with the exception of funds for defence research – are initiated and organised by the Federal Ministry of Research and Technology, which calls upon expert advice. The staff of the national research centres also sometimes function as project co-ordinators in administering these programmes. Some of these major projects involve the spheres of activity of several of the federal ministries and are jointly co-ordinated by them. These include the programme for research and development on behalf of health.

Just under half the funds made available by the Federal Ministry of Research and Technology go to state or state-assisted research bodies and institutes such as the Max Planck Society (P 32), the national research centres (P 35), and institutes jointly financed by the federal authorities and the Laender, and also such international organisations as the Euro-

pean Nuclear Research Centre (CERN) and the European Space Agency (ESA). Somewhat over half the available finance is devoted to individual projects, mostly in industry and only to a limited extent in universities or other state-financed non-university research set-ups. Big firms in research-intensive branches of industry offer particularly favourable conditions for project assistance with their individual laboratories. Innovatory dynamism is not, however, primarily a matter of size of firm, even though large companies' capital, possibilities of risk-distribution, and extensive production-capacity do offer better preconditions for longer-term research and development. Medium-size and small enterprises are nevertheless frequently superior in their rapid utilisation of highly promising innovations. A balance is achieved by way of joint industrial research, which is mainly organised through the Cologne-based Union of Industrial Research Associations (AIF, P 43) which receives backing from the Federal Ministries of Economics and of Research and Technology. For some years now the Federal Government has itself been developing promoting innovations even in small and medium-sized firms. Since then such firms have received very much more in the way of assistance, particularly in the spheres of optics, metrology, production engineering, the application of electronic construction elements, and in the programme for humanising the world of labour.

Direct financial assistance is accompanied by indirect measures which are not limited to specific programmes or criteria. Such indirect measures include AIF-mediated grants (1985: 380 million DM) for staffing costs in research and development, subsidies for R & D investment, and tax concessions for expenditure on contract research and development elsewhere. Finally, the Federal Government also aids technology transfer from universities and other research bodies into everyday practice, meaning both industry and the public health service and local government.

Table 8

Objectives and emphases in Federal assistance for research and development

Objectives	Emphases	Million DM 1985 (target)
Extension of scientific knowledge	Support organisations (Max Planck Society, German Research Society, Fraunhofer Society) University building (R & D element)	1,441

Objectives	Emphases	Million DM 1985 (target)
	Basic scientific research (selected spheres)[1]	856
	Polar research, marine research and technology	236
	Space research and technology	827
Increase in industrial productivity and competitiveness	Energy research and technology	2,318
	Earth sciences and raw material supplies	108
	Research and technology for land transport & communications (inclusive of safety)	202
	Research & development in air transport	738
	Information technology	654
	Biotechnology	146
	Materials research; chemical process engineering; physical technologies	344
	Innovations and improvements in back-up facilities (Indirect assistance, transfers of technology)	667
Preservation of resources and the environment. Improvement of living and working conditions	Environmental research; research into climate; Safety research and technology	601
	Planning and urban construction; building research	158
	R & D in health	368
	R & D in nutrition	75
	R & D in agriculture, forestry, and fishing	213
	Humanisation of the world of work	126
	Research in education and vocational training	122
	Specialised information	70
	Humanities, economics, and social sciences	229
	Other research	79
	Defence research and technology	2,509
	Total federal R & D expenditure	13,087

[1] Contributions to basic research are also contained in the other emphases

Source: Faktenbericht 1986 zum Bundesbericht Forschung

III. *Laender Research Policy*

The Laender are responsible for virtually all the institutions of higher education in the Federal Republic of Germany, thereby ensuring their basic provision for research. The Laender concerned also assist the five scholarly academies (P 30) and a number of Land research institutes (P 40 ff). In addition they devote considerable sums of money (as table 7 shows) to joint provision for research by the federal authorities and the Laender. They are represented too in such assisted institutes and scholarly organisations as the German Research Society (P 57) and the Science Council (P 50). If what is at issue concerns the Laender as a whole rather than an individual Land, representatives are nominated by the Standing Conference of Laender Ministers of Education (P 49).

At the same time the Laender are increasingly setting their own research priorities – and not just in regions covering a large area (such as Baden-Württemberg or North Rhine-Westphalia) but also in the more confined city-states (Berlin and Hamburg). This establishing of emphases involves both discussions with and between institutions of higher education about their plans for the future and Land projections inclusive of non-university state-financed research facilities and industry.

Where resources are limited, particularly in the sphere of the new technologies, great competition inevitably develops between the Laender. For more extensive projects co-ordination with the federal and Laender programmes is necessary too.

The Laender are also involved in scientific co-operation at the international level, particularly where higher education is concerned. Representatives of the federal authorities and the Laender (the latter again nominated by the Conference of Ministers of Education) work together in Federal German delegations to both the big international organisations for scholarly co-operation (such as the OECD and the Council of Europe) and on bilateral projects.

IV. *The German Research Society and the Foundations*

1. The German Research Society – Deutsche Forschungsgemeinschaft

– An autonomous central organisation for the promotion of scholarship –

Anyone who does not have sufficient funds for his research project, who needs one or more co-workers, who wants to apply for a fellowship for himself or another young scientist, who lacks scientific equipment, or the money for other facilities or a research trip abroad, can apply to the Deutsche Forschungsgemeinschaft – DFG based in Bonn-Bad Godesberg. Over 6.500 scientists do just that year after year. Around three quarters can reckon with a positive outcome after their applications have been subjected to highly detailed examination. Every four years, scientists in the Federal Republic of Germany elect by secret ballot almost 450 expert consultants in 172 disciplines ranging from Old Testament theology to electrotechnology and information studies. An independent written report on every application is produced by several of these consultants. A decision is then taken by the Society's Grants Committee, composed of scientists with a diversity of specialisations and representatives of the federal authorities, the Laender, and the Donors' Association for the Promotion of Sciences and Humanities in Germany (P 62). The German Research Society reaches decisions on over 10,000 applications annually inclusive of the priority programme (Schwerpunktprogramm) and the special collaborative programmes (Sonderforschungsbereiche; P 25). Its financial resources exceed a milliard DM.

The DFG is the child of emergency. It dates back to the Emergency Association for German Science (Notgemeinschaft der deutschen Wissenschaft) set up at Berlin in 1920 after World War I. Immediately after that, a group of leading representatives of politics, industry, and science established the Donors' Federation to provide support for the Notgemeinschaft (P 62). The Notgemeinschaft was re-founded in 1949 in a similar situation after World War II. Its activities were at first limited to alleviation of immediate financial need. These were soon complemented by other functions with a greater emphasis on research policy. The tasks of the Deutsche Forschungsgemeinschaft – as the organisation became known after amalgamation in 1951 with the Research Council also set up after the war – include provision of financial support for research projects, assistance for co-operation between researchers, provision of advice on

scientific issues for parliaments and public authorities, fostering links between research and industry and science in other countries, and assistance for the training of young scientists. The German Research Society has thus become a central organisation for the promotion of science in the Federal Republic of Germany, and is particularly crucial with regard to assistance for fundamental research.

Its financial assistance is not just restricted to individual research projects or more extensive programmes. It also provides assistance for scientific libraries, and for the equipment of computer centres at universities and such central research facilities as the research vessel "Meteor" and the Mannheim centre for surveys, methods, and analyses in social science. The DFG is not, however, committed to long-term backing for such enterprises.

Assistance for co-operation between researchers does not only involve concentrated help for priority programmes, special collaborative programmes, and small research units. It also includes the financing of specialised discussions and colloquia. In the provision of advice for parliaments and public authorities, a large number of specialised commissions and committees supply the scientific basis for legislation, particularly in the sphere of protection of the environment and preventive medicine. The Society also evaluates proposals for equipping universities with scientific equipment as part of state aid. The committee for applied research is especially concerned with the link with industry. At the international level the Deutsche Forschungsgemeinschaft represents German science in many international organisations. It co-ordinates and finances German participation in large international research programmes, and there are relations, agreements, and exchanges with many scientific organisations abroad (P 70ff).

The German Research Society also runs the Gottfried Wilhelm Leibniz Programme for the Advancement of Selected Researchers and Research Groups. A total of 150 million DM is expected to be available for this special incentive programme for a nine year period from 1986. The federal government provides 75 % of these funds and the Laender 25 %.

Around half of the funds received by the DFG are devoted to payment of scholars and auxiliary staff, thus making a considerable contribution towards assisting young scholars. That is complemented by special fellowship programmes, e. g. the post-doctorial and the Heisenberg-Programme (P 67).

German Research Society – Deutsche Forschungsgemeinschaft, Bonn – Bad Godesberg, registered association under civil law

Members:

a) Universities provided that they are institutions of research carrying out general importance (at present 51 universities etc)
b) Other research institutions of general importance
   The Max Planck Society, the Fraunhofer Society, 8 National Research Centres, the German Archaeological Institute, the Federal Office of Physics and Technology, and the Prussian State Museums
c) the 5 Academies of Science in the Federal Republic
d) Scientific associations of general importance
   The Union of Industrial Research Associations, the German Federation of Technical and Scientific Associations, and the Society of German Natural Scientists and Physicians.

Most important committees, etc

- the *general assembly*, which among other things elects the executive board and senate
- the *executive board* with a scientist as full-time president, 7 scientists as vice-presidents, and the chairman of the executive board of the Donors' Association for the Promotion of Sciences and Humanities in Germany as advisory member
- the *senate* with 33 scientific members. 30 of these are elected for a 3 year term by the general assembly, and their number is completed by the president of the West German Rector's Conference, the chairman of the Conference of Scientific Academies, and the president of the Max Planck Society. The senate is the Society's main forum for scientific policy
- the *grants committee* consisting of 15 members of the senate, 6 each from the federal authorities and the Laender, and 2 representatives of the Donors' Association. This committee is responsible for financial assistance for research
- the *board of trustees* which consists of the members of the senate, 6 representatives of the federal authorities, 11 representatives of the Laender, and 5 from the Donors' Association. This body meets once a year for passing resolutions on general financial matters with particular emphasis on the budget

- the *scientific elected reviewers' committees* consisting of elected specialists
- the *grants committee for special collaborative programmes*
- the *committee for international relations*
- the *committee for applied research*
- the *library committee*
- the *selection committee for the Heisenberg programme* for the assistance of especially qualified young scholars
- the *senate commissions* for specific important areas of work ranging from educational science and empirical social research to investigation of health hazards in chemical compounds, joint research in earth sciences, and oceanography.

Financing: for general research, half from the federal authorities and half from the Laender; for special collaborative programmes, 75% from the federal authorities and 25% from the Laender in accordance with the Outline Agreement on the Promotion of Research. Also available is federal assistance for special projects, and additional help from the Donors' Association and other foundations. Total – over a milliard DM.

2. The Foundations

The fact that the German currency and private fortunes have collapsed twice within a quarter of a century, and also the widespread view in this country that general promotion of science is mainly a matter for the state, may be responsible for such assistance having been so underdeveloped in the Federal Republic of Germany for so long – leaving aside the Donors' Association for the Promotion of Sciences and Humanities in Germany as a collective body. That situation changed at the end of the 1950s and the start of the 1960s as the result of two remarkable new organisations.

The Fritz Thyssen Foundation

The Fritz Thyssen Foundation was established in 1959, endowed with a capital of 270 million DM, by the heirs to a large steel concern. The foundation is exclusively devoted to the promotion of scholarship (with special

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emphasis on the younger generation) at universities and research centres mainly in the Federal Republic of Germany. This organisation chiefly aids research projects due to be completed within a specific period, and over 240 million DM have been made available since its establishment.
The Foundation provides assistance in response to applications, but also itself suggests projects and occasionally organises scholarly symposia and lecture series. It does not, however, maintain its own research institute or teaching facilities, and never, as a matter of principle, assists projects in areas where the Foundation's funds originate.
The Fritz Thyssen Foundation's support for research is mainly concentrated in four spheres: basic research in the humanities; international relations; state, economy, and society; and medicine and the natural sciences. It is also interested in incorporating foreign scholars' talents and ideas in its programme.

The Volkswagenwerk Foundation

Another important step forward was taken when the Volkswagenwerk Foundation was set up in 1961 by the federal authorities and the Land of Lower Saxony as part of the process of returning the firm to private ownership. The Foundation's capital now amounts to around 1.36 milliard DM. In recent years it has been able to make available over 100 million DM in research funds annually. That makes it the most powerful science foundation in Europe, comparable in its facilities with the big North American foundations. The Volkswagenwerk Foundation is particularly concerned with spheres of research that, by international standards, are either inadequately assisted or insufficiently developed in the Federal Republic of Germany, and also with interdisciplinary and international (or at least supra-regional) scholarly co-operation. It only provides assistance

- that supplements (rather than replaces) public money
- with a time limit, sometimes taking the form of project allowances, fellowships, or "initial assistance" so as to have funds constantly available for new initiatives
- and, as a matter of principle, only in main areas of emphasis so as to be able to concentrate resources and talent on what are thought to be the most urgent spheres and problems.

The main priority programmes are therefore not rigid but are adapted to prevailing demands. The number of such priority programmes ranges between 20 and 30, of which around a half are devoted to the humanities and the social sciences. The Foundation has recently increased its assistance for the natural sciences and engineering as is shown by such current foci as "Synergism", "Micro-structures", "Mathematical and theoretical

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foundations of engineering", "Process models of production techniques", "Metallic and ceramic materials", "Processes of technical combustion", and "Partnership with institutes of natural science and engineering abroad". The focus on "Archaeometry" promotes co-operation between the natural sciences and the humanities.
In the spheres of the humanities and social sciences the Volkswagenwerk Foundation is particularly concerned with issues that contribute – possibly only over the longer term – to recognition and solution of social problems. Among such themes are: "Changing democratic industrial societies", "The European Community's expansion southwards", "History and future of European urban research", "Management of research and development", and regional research in the Third World (P 72).

Other foundations and initiatives

Other foundations established in recent years – such as the Robert Bosch Foundation and the Alfried Krupp von Bohlen und Halbach Foundation – have considerably increased the capital and effectiveness of these and similar organisations together with the bodies providing assistance to universities. The donations and funds administered by the Donors' Association for the Promotion of Sciences and Humanities in Germany have been of particular importance in recent years (see below). And yet the amount of financial assistance provided by these foundations is not remotely comparable with what is available from the state, the German Research Society, or from an extended network of large foundations and an expansion of "corporate giving" as in the United States of America. The foundations' particular function consists, however, – as was made clear in one of the Volkswagenwerk Foundation's recent annual reports – of taking up themes and areas to which the state and other sources of research finance have not as yet devoted sufficient attention. It is just because of this form of selective emphasis that the foundations can stimulate developments, compensate for one-sidedness, and help establish models for further advance.

3. The Donors' Association for the Promotion of Sciences and Humanities in Germany – Stifterverband für die Deutsche Wissenschaft

The Donors' Association – Stifterverband – is a joint enterprise on the part of industry for promoting science and technology in research and teaching, and for assisting young scientists and technologists. The motives

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for its activities are basically the same as those which led in 1920 to establishment of the former set-up – namely, the recognition that assistance for science is not just a matter for the state but that industry must also demonstrate its interest in assistance (particularly for basic research) with financial contributions of its own. The Donors' Association at the same time aims at expanding the field for scientific and creative work freed as far as possible from the state's administrative restrictions, and hopes that will also help bring about top-class scientific achievements. It does not intend to take the state's place in promotion of science but rather to make a contribution through specific measures towards preservation of the diversity of scientific work in our country, and towards independent pursuit of research and teaching. Karl Carstens, former President of the Federal Republic of Germany, has also spoken of the benefits (and not just material benefits) that thereby flow back to industry: "An industry that makes use of its right to promote science by way of foundations thus ultimately strengthens its own freedom".

The Donors' Association, which is registered as a non-profit-making association, today receives backing from some 5,000 members and supporters – individuals, firms, and federations – which provide between 35 and 40 million DM a year. It should be born in mind too that this money is not intended for specific research and development projects but constitutes public-spirited contributions towards general promotion of science. The Donors' Association also acts as trustee to over 100 autonomous foundations and funds, which provide over 25 million DM a year. This trusteeship, entailing a minimum of administrative involvement, makes it possible to link up the wishes of the individual donor with the Foundation's overall policy.

Many scientific institutions and institutions for the promotion of science derive benefit from the activities of the Donors' Association, including the German Research Society, the Max Planck Society, the German National Scholarship Foundation (Studienstiftung des deutschen Volkes; P 65), the German Academic Exchange Service (P 96) and the Alexander von Humboldt Foundation (P 94).

The main emphases in the Donors' Association's work are at present as follows:

- International scientific co-operation
- Medical research
- Research in the humanities
- Structure and organisation of science
- Science and the public
- Assistance for young scientists.

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Within this programme, the Association finances international research conferences, medical projects contributing to research into cancer and multiple sclerosis, foundation professorships, and competitions in mathematics and modern languages for youngsters at school. The Association's Science Centre in Bad Godesberg is an architecturally interesting modern meeting-place for people from organisations serving science. Scientific life in the Federal Republic of Germany would be more than just materially poorer if this joint foundation did not exist.

V. *Assistance for Young Scientists*

A large proportion of research results are based on the work of young scientists. Many of them are preparing for a career as university teacher or for a research job inside or outside university. Many of them also want to work for a time as a scientist before moving on to other jobs. The demand for scientifically qualified young people is growing all over the world. Assistance for young scientists in the Federal Republic of Germany must, however, also take into account the fact that the vocational opportunities for young scientists can vary widely. If, as has happened in our country, a large number of university posts have been filled with relatively young scientists during a period of great expansion, and that is then followed by a time when expansion slows down or there is even stagnation, the opportunities for the next generation are reduced. The various assistance measures for young scientists in the Federal Republic therefore also aim at giving qualified young people in each generation (and particularly now when those born in years with high birth-rates are passing through university) an opportunity of finding a scientific task and giving of their best. Young scientists are mainly trained at universities, which have the posts for professorial assistants and funds to pay such auxiliary staff. The additional money provided by the German Research Society, the foundations, and the other sources of assistance for research help here to a great extent. In addition, the German Research Society offers special fellowships for scientists who want to qualify as university lecturers. The Max Planck Society also makes fellowships available in its institutes to young scientists from Germany and other countries. The Association of National Research Centres has developed its own programme for assisting the up-and-coming generation. The Federal Ministry of Education and Science's post-doctorial programme, launched in 1985, also belongs in this context. This envisages the provision of assistance for around 400 young scholars who have already gained a doctorate and wish to extend their qualifica-

tions by devoting 2 or 3 years to university research before moving on to a non-university job. This programme, administered by the German Research Society, is thus intended to contribute to transfers of knowledge between pure and applied research, particularly within the national economy.

Assistance for young scientists must, however, begin very much earlier with assistance for gifted students. That is the task of special organisations.

Assistance for the gifted

The Bad Godesberg-based German National Scholarship Foundation (Studienstiftung des deutschen Volkes) is the largest among the eight organisations that assist students and doctorial candidates. It was founded in 1925, re-established in 1948, and in 1985 provided help for more than 4,000 people.

Four of these organisations have close links with political parties:

The *Friedrich Ebert Foundation* in Bonn-Bad Godesberg was set up in 1925 as a legacy of Germany's first President, Social Democrat Friedrich Ebert. Today around 1300 students receive assistance from this organisation.

The *Konrad Adenauer Foundation*, established in 1964, bears the name of the Federal Republic's first Chancellor, a Christian Democrat. It aids also around 1300 students.

The Bonn-based *Friedrich Naumann Foundation*, named after the turn-of-the-century liberal politician, owed its foundation in 1958 to Professor Theodor Heuss, the first President of the Federal Republic of Germany. This foundation helps just under 400 people.

The *Hanns Seidel Foundation*, named after Bavaria's Prime Minister from 1957 to 1960, was incorporated in the Federal Ministry of Education and Science's assistance programme in 1982. Its activities are still being developed so it is only responsible for around 300 scholarship-holders.

The Co-Determination Foundation, set up by the German Trade Union Federation in 1954, is now named the *Hans Böckler Foundation* after the union leader. Out of that there developed the Federation's assistance-for-studies programme at the end of the Sixties. Most of the somewhat under 1600 scholarshipholders involved come from workers' families, and after leaving school completed vocational training and had a job before qualifying in evening classes for university studies.

Two other organisations are linked with the Churches:

The Protestant Scholarship Foundation (*Evangelisches Studienwerk*) was set up in 1948 at Villigst on the fringes of the Ruhr, and now helps just

under 800 students. The Episcopal Cusanus Scholarship Fund (*Bischöfliche Studienförderung Cusanuswerk*) in Bonn-Bad Godesberg was established in 1956, and now looks after somewhat over 600 scholarship-holders.

These eight organisations finance their assistance for students almost completely from the funds provided by the Federal Government, which in 1986 amounted just under 80 million DM. Only a small amount of money is put up by the Laender and local authorities for the Scholarship Foundation, or by their backers and members for the other organisations.

Despite all their individual differences as expressed in statutes and objectives, these organisations share a number of basic principles. Their work centres around the expectation of special achievements in studies and scholarly work, assistance for particular commitment to community and society in the Federal Republic of Germany, material support by way of scholarships, and personal and intellectual support for students.

The organisations providing assistance for the gifted thus make an important contribution to both scholarly promotion of the especially talented and the development of the recipients' sense of social and political responsibility – and thereby to the expansion and securing of our democracy.

Anyone with insufficient means can receive assistance in accordance with the federal law regulating assistance for training (BAföG, since 1971), for which the federal authorities make available annually over 1.5 milliard DM in grants and loans for young people involved in various branches of the school, polytechnic, and university system.

The 1971 federal law regulating assistance for graduates ceased to apply in 1981 and was formally revoked two years later. In 1985 the Laender assumed legal responsibility for assisting doctorial candidates. These laws have been unified to the greatest possible extent. The grant amounts to 1,200 DM monthly with an additional 300 DM for the married. When these laws come fully into effect, just under 2,500 scholarships will be available annually. Such assistance is not limited to German nationals.

The Fritz Thyssen Foundation has since 1984 been trying out what is still a new form of assistance for particularly talented young scientists in the Federal Republic. This is a graduate seminar in molecular biology at Cologne University, derived, after years of experience, from the PhD Programme at New York's Rockefeller University. The objective is the provision of specialised interdisciplinary assistance for particularly qualified (and usually German) graduates. Unpaid tutors, caring for at most two graduates, look after them during their time with the seminar. This model played a part in the Science Council's recommendation at the beginning of 1986 that graduate seminars should be established at univer-

sities where the requisite preconditions exist.

A gratifyingly increasing number of awards and prizes also serves the advancement of up-and-coming young scholars. The most important of these prizes, presented by the Federal Ministry of Education and Science, is specifically for young scholars. This is named after Professor Heinz Maier-Leibnitz, the former president of the German Research Society, and a total of 100,000 DM is awarded to some 10 or so scholars in different disciplines each year.

A particular problem has developed for university assistants who have demonstrated by their habilitation (or something comparable) their qualifications as a university teacher but, because of the age structure at universities, have to wait for a long time for a post as professor. The Heisenberg Programme for the Assistance of Highly-Qualified Young Scientists, named after Nobel Prizewinner Werner Heisenberg, was established for such people in 1977 in accordance with a resolution by the Federal Chancellor and the Laender Prime Ministers. This programme, which is financed to an equal extent by the federal authorities and the Laender, provides fellowships for up to 150 scientists a year. The Volkswagenwerk Foundation's university lecturers' programme serves the same purpose albeit on a much smaller scale.

Some Laender plan to establish a limited number of additional professorships in the years ahead, but those will be discontinued when the age structure becomes more favourable[1].

The rich diversity of the promotion of science in the Federal Republic of Germany is reflected in the provision made for young scientists. Gaining an overview of what is available is not made easier by the fact that a number of young scientists receive a variety of forms of assistance in the course of their training. On the other hand, it is precisely this diversity that makes it possible to provide individually-tailored assistance.

[1] Fiebiger-Plan (the idea came from the President of Erlangen-Nuremberg University, Professor Fiebiger).

VI. *Research and Development in Industry*

Over half of the total number of people employed in research in the Federal Republic work in industrial firms (Table, 1, P 17). Of the total of over 52 milliard DM devoted to research and development, about two thirds (36 milliard DM) are accounted for by industry (Table 4, P 20). This is a high proportion even when the difference in cost structure between basic

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research and the production-oriented R & D pursued by industry is taken into account.

The Donors' Association for Scientific Statistics Inc, an offshoot of the Donors' Association for the Promotion of Sciences and Humanities in Germany (P 62), assembles detailed statistics on the amount of money spent on research and development by the individual branches of industry. 1983 expenditure was highest in electro-technology (amounting to 7.6% of turnover). Precision mechanics and optics (4.8%), the chemical industry (4,4%), and mechanical engineering (4.0%) also attracted above-average (3.0%) ratios of R & D to turnover. Around four fifths of all industrial expenditure on research and development is accounted for by these spheres.

Industry itself meets about 80% of its expenditure on R & D, providing just under 30 of the 1985 total of 36 milliard DM. The rest comes from state aid, principally from the federal research programmes and the federal government's staffing subsidies for research carried out within a firm.

The amount of state aid varies considerably between different branches of industry. In the aero-space industry it amounts to around 68% (1983). State finance also plays an appreciable part in electro-technology (around 12%) whereas R & D in the chemical and automobile industries receives very little state aid. These figures are changing though along with the structure of the state research programme.

Around 560 million DM (1983) are devoted to joint industrial research while the rest is accounted for by the activities of individual firms. For the former, which is supervised by the Union of Industrial Research Associations, the state pays a subsidy of around 300 million DM. Around 22% of the expenditure on industrial R & D goes to small and medium-sized firms with fewer than 1,000 employees.

A discussion has developed in industry about state financing of research in the Federal Republic of Germany against a background of increasing state activity in this sphere. There are people who believe that increasing amounts of direct financial assistance for R & D are irreconcilable with our market economy, and want an intensification of indirect measures which are more neutral with regard to competition. On the other hand there is acceptance of the fact that technical developments which demand high expenditure and whose hoped-for economic utility can only be expected in the longer term cannot be implemented without state aid in a situation of international competition. The state helps firms to bear unacceptable aspects of technical and economic risk involved in new developments.

Examples of that are provided by the protracted and high-risk technical

developments entailed in new transport systems, advanced nuclear reactors, micro-electronics, the health service, communications, and also in technical aid for the developing countries. Here too, however, the basic principle applies of not making industry dependent on the state as a result of this assistance but rather of upholding industrial productivity and competitiveness, and of enabling industry to profitably produce those goods that are necessary for mastering social tasks.

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D International Co-operation

I. *International Scientific Co-operation at Governmental and Non-Governmental Levels*

The first international scientific society of this kind was the Union for Magnetic Studies, established by Alexander von Humboldt in 1829. Even a hundred years later, co-operation between researchers was characterised by correspondence between a small circle of scientists who know one another, as was the case with physicists in the 1920s and 1930s.

Today our earth is covered with an ever-denser network of informal and institutionalised scientific relations. Thousands of scientists fly to a congress whose location rotates from continent to continent. Research projects of a truly global extent, as in the earth sciences, bring together scientists from many countries. International workshops, innumerable projects involving a few individual scientists, and exchanges of scientists are not less important. Governmental and non-governmental organisations cultivate co-operation in which an ever-larger number of scientists and countries are involved.

Researchers, universities, research facilities, research organisations, and the federal and Laender governments all participate intensively and diversely in this co-operation. This is based on the traditional European comprehension of freedom of scholarship, which has also been taken over by many of the "young" nations in their pursuit of research. This approach does not, as a matter of principle, recognise any frontiers, gaining utility and deriving fresh impulses from direct co-operation between researchers and from exchanges of experiences, methods, and results. Many researchers in the Federal Republic of Germany thus cultivate relations with colleagues in other countries even without the benefit of government or other aid. The universities establish partnerships, and over 900 of these are now recorded in the West German Rectors' Conference register (P 27). All that takes place without any centralised direction, organisation, or assistance. In recent years though, some Laender have made available centralized funds for assisting university partnerships, and attempted to incorporate university contacts as essential factors in co-operation with Third World countries.

Assistance beyond what university budgets provide becomes necessary though wherever additional funds are required, or wherever special experience is useful because of the increasing extent and diversity of relations. Both are becoming increasingly important ever since the expansion of universities and research facilities resulted in an ever greater number of

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researchers (as compared with only a few in earlier times) being interested in international co-operation at a time when there has also been a growth in the number of possible partners in other countries. This assistance comes from the German Research Society, the foundations (P 60), and, above all, from the mediator organisations (P 94) active in the sphere of international co-operation and exchanges of scientists.

For individual projects the German Research Society – Deutsche Forschungsgemeinschaft (DFG) makes available assistance for research trips, and fellowships for young scientists involved in research or further studies. A considerable amount of money is devoted to a number of more extensive projects involving German researchers abroad, which at the same time serve co-operation with researchers in the host country. Examples of that include extensive archaeological excavations in Greece and the Near East, the Africa cartographic project and the Tübingen Atlas of the Near East, research into culture in the central highland in West Irian, and work in Nepal. One special collaborative programme is concerned with the geo-scientific problems of arid areas in North-East Africa, and another with tropical agriculture in West Africa. For over a decade now the Society's Mexico project has brought together Mexican and German scientists to work on archaeological, historical, economic, and geographical research and in the field of the natural sciences. The DFG also enables universities to issue invitations to guest professors. With its help, foreign staff can take part, for a limited time, in research in the Federal Republic of Germany if the host institute thinks this necessary.

The German Research Society has also assisted German participation in such extensive international research programmes as the International Geophysical Year and in other geo-scientific and oceanographic joint projects. It has represented research in the Federal Republic of Germany in many international organisations, being member of the International Council of Scientific Unions, the European Science Foundation (together with the Max Planck Society and the Conference of Academies of Science), the International Foundation for Science, and the Council for International Organisations of Medical Sciences. Table 9 (P 74) provides an overview of these diverse activities. The Society offers financial assistance for representation of German science in the specialised committees of the International Council of Scientific Unions and other international organisations for which the specialised scientific societies are generally responsible. It receives special funds from the Federal Ministry of Research and Technology for providing assistance for meetings in the Federal Republic of Germany of the big international scientific societies and associations, and also for the annual meeting of Nobel Prizewinners at Lindau on Lake

Constance. Funds from the Federal Foreign Office provide backing for the participation of German scientists in big international congresses overseas and in Eastern Europe.

An agreement between the German Research Society and the Federal Ministry of Economic Co-operation provides additional funds for German scientists' research projects in the developing countries.

The foundations complement these measures in their individual ways. The Volkswagenwerk Foundation, for instance, has given support since the early Sixties to research of contemporary relevance in specific areas: initially Latin America, East Asia, Eastern Europe, and the Near and Middle East – and since 1976/77 South-East Asia and North American Studies (until the end of 1986). The emphasis on "Basic Development in Latin America, Asia, and Africa" and the partnership programme with foreign institutes of engineering and the natural sciences specifically involve countries with developing structures of science. Since 1975 the Volkswagenwerk Foundation has provided assistance for the international centres at universities in the Federal Republic of Germany which are being developed by the Alexander von Humboldt Foundation. Like the big American foundations, the Volkswagenwerk Foundation also gives money directly to foreign research centres, particularly for projects involving co-operation with German scientists.

The Fritz Thyssen Foundation assists scholarly studies on "International Relations" in both the Federal Republic and other countries but preferably involving international co-operation – in such spheres as security, international law, and issues in economics. It promotes international exchanges of scholars by way of the Alexander von Humboldt Foundation, the German Academic Exchange Service, and a German-American scholarship programme at the Chicago Law School.

The Donors' Association for the Promotion of Sciences and Humanities in Germany assists the Dahlem conferences in Berlin (West) as a particularly intensive form of international scientific discussion. It also helps make possible the maintenance of contact with foreign research fellows when they have returned to their home countries, and provides backing for the annual meeting of Nobel Prizewinners at Lindau on Lake Constance. The Association finances young researchers' work on the problems of the developing countries, and is involved in the development of language courses for foreign students.

The German Research Society has concluded formal agreements with a number of European and other organisations concerned with assistance for research (see table 10 on P 77), and has special arrangements with others or regularly exchanges experiences. The formal agreements mainly

involve partners in three regions:

1. The Soviet Union and socialist countries in Europe. Here formal agreements are the precondition for scientific co-operation. The agreements and arrangements concluded by the Society often fill a gap here if for general political reasons scientific relations do not exist at government level or lapse for a period.
2. Western Europe. There are in fact no restrictions on relations between individual scientists, universities, and research centres but the Society and its partners want to give a boost to European co-operation.
3. Developing countries. Here the agreements serve the development of new partnerships and the easing of conditions for joint work.

The objectives in the Federal Government's foreign, trade, and development aid policies are also reflected in international co-operation between states on research and technology.

In the sphere of foreign affairs, research policy makes a contribution to the international co-operation supported by the Federal Government, particularly within the framework of the European Community. Particular mention should be made of the programme for the stimulation of European co-operation and exchange within the sphere of science and technology, and for research and development in biotechnology, basic research on industrial technologies (BRITE), information technology (ESPRIT), and advanced communication technologies (RACE). Such endeavours are backed by the European Community's programme for advanced technological training (COMETT), and the far-reaching new initiatives for intensification of European technological co-operation (EUREKA). As far as foreign trade is concerned, research policy intensifies co-operation with countries that export oil and raw materials. In development aid policy, the Federal Government is seeking new ways of scientific and technical co-operation with the developing countries so as to make a contribution through research and technology to the economic and social development of the Third World. In the case of developing countries which have already established the beginnings of research capacity, co-operation on the basis of partnership is an important starting-point in jointly-defined research projects. The federal authorities and the Laender work together with universities from the developing countries in the "University Partnerships" discussion group.

Table 11 (P 78) provides an overview of agreements concluded by the Federal Republic of Germany on scientific and technological co-operation.

Table 12 (P 93) lists the international organisations or research centres in which the Federal Republic of Germany is involved.

Table 9

German Research Society (DFG) membership of international scientific organisations

International abbreviation	Name of the Organisation	German representation
1. International scientific umbrella organisations		
ICSU	International Council of Scientific Unions	DFG
with following commissions and projects:		
SCAR	Scientific Committee on Antarctic Research	National committee SCAR
SCOR	Scientific Committee on Oceanic Research	National committee SCOR
COSPAR	Committee on Space Research	National committee COSPAR
COWAR	Scientific Committee on Water Research	Individual DFG representatives
CODATA	Committee on Data for Science and Technology	National committee CODATA
SCOPE	Scientific Committee on Problems of the Environment	National committee SCOPE
SCOSTEP	Special Committee on Solar-Terrestrial Physics	National committee SCOSTEP
COSTED	Committee on Science and Technology in Developing Countries	Individual DFG representatives
WCRP	World Climate Research Programme	DFG Senate commission for Atmospheric Sciences
IGCP	International Geological Correlation Programme	National committee for the International Geological Correlation Programme
ILP	International Lithosphere Project	National ILP committee

International abbreviation	Name of the Organisation	German representation
CIOMS	Council for International Organisations of Medical Sciences	DFG
IFS	International Foundation for Science	DFG
ESF	European Science Foundation	DFG/Max Planck Society/ Conference of Academies
with sub-groups:		
ESRC	European Science Research Councils Standing Committee of the ESF	Individual DFG representatives
EMRC	European Medical Research Councils, Standing Committee of the ESF	Individual DFG representatives

2. International Specialist Unions (ICSU members)

IAU	International Astronomical Union	West German Observatories Council
IGU	International Geographical Union	Central Association of German Geographers
with the sub-group:		German IGU national committee
IKV	International Association of Cartographers	German Cartographical Society
IUGG	International Union of Geodesy and Geophysics	National committee for Geodesy and Geophysics
IUGS	International Union of Geological Sciences	Federal German IUGS national committee
IUPAC	International Union of Pure and Applied Chemistry	German Central Chemical Committee
URSI	Union Radio Scientifique International	West German URSI national committee

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International abbreviation	Name of the Organisation	German representation
IUPAP	International Union of Pure and Applied Physics	German IUPAP national committee
with the sub-group: ICO	International Commission for Optics	German Optics Committee
IUBS	International Union of Biological Sciences	German IUBS national committee
IUTAM	International Union of Theoretical and Applied Mechanics	German section of the Society for Applied Mathematics and Mechanics (GAMM)
IUHPS	International Union of the History and Philosophy of Science	German IUHPS national committee
with the sub-group: DLMPS	Division for Logic, Methodology and Philosophy of Science of the IUHPS	German Association for Mathematics, Logic, and Basic Research in the Exact Sciences (DVMLG)
IUCr	International Union of Crystallography	Crystallography Association
IMU	International Mathematical Union	German Mathematical Association
IUPS	International Union of Physiological Sciences	German Physiological Society
IUB	International Union of Biochemistry	Biochemical Society
IUPHAR	International Union of Pharmacology	German Pharmacological Society
IUPAB	International Union of Pure and Applied Biophysics	German IUPAB national committee
IUNS	International Union of Nutritional Sciences	German Nutrition Society
IUIS	International Union of Immunological Sciences	Immunological Society e. V.

Source: German Research Society. Annual reports

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Table 10

Agreements between the German Research Society and partner organisations abroad – as of 1985

Country	Partner		Date
Europe			
Bulgaria	Academy of Sciences	(BAN)	14. 3. 1975
Czechoslovakia	Academy of Sciences	(CSAV)	28. 4./ 12. 6. 1969
Finland	Academy of Finland	(AF)	17. 2. 1981
France	Centre National de la Recherche Scientifique	(CNRS)	1. 2. 1971
	Institut National de la Santé et de la Recherche Médicale	(INSERM)	12. 1. 1981
Great Britain	Royal Society	(RS)	28. 4. 1967
	Social Science Research Council	(SSRC)	25. 4. 1977
Hungary	Academy of Sciences (MTA – as successor to the Institute for Cultural Relations KKI)		26. 2. 1981 (27. 10. 1978)
Italy	Consiglio Nazionale delle Ricerche	(CNR)	15. 6. 1977
Poland	Academy of Sciences	(PAN)	19. 6. 1974
Rumania	Academy of Sciences	(ARSR)	21. 10. 1976
Spain	Consejo Superior de Investigaciones Científicas	(CSIC)	16. 12. 70/ 29. 1. 71
Turkey	Türkiye Bilimsel ve Teknik Arastirma Kurumu	(TÜBITAK)	3. 10. 1984
USSR	Academy of Sciences	(AN SSSR)	28. 9. 1970
Overseas			
Bolivia	Consejo Nacional de Educación Superior	(CONES)	5. 8. 1976
Brazil	Conselho Nacional de Desenvolvimento	(CNPq)	5. 4. 1984
Canada	Natural Sciences and Engineering Research Council of Canada	(NSERC)	16. 6. 1983
Chile	Comisión Nacional de Investigación Científica y Tecnológica	(CONICYT)	28. 11. 1979
Chinese Peoples Republic	Academy of Social Sciences	(CASS)	5. 11. 1981
Egypt	Academy of Scientific Research and Technology	(ASRT)	9. 5. 1974
Korea	Korean Science and Engineering Foundation	(KOSEF)	4. 7. 1977

Philippines	National Academy of Science and Technology of the Philippines	(NAST)	12. 12. 1983
	National Research Council of the Philippines	(NRC)	12. 12. 1983
Taiwan	National Research Council	(NSC)	5. 11. 1981
Thailand	National Research Council	(NRC)	11. 9. 1978
USA	National Science Foundation	(NSF)	24. 6. 1980

Table 11

Federal German agreements on scientific and technological co-operation

Co-signatories	Nature of agreement	Substance	in force since
Argentine			
Governments	Outline treaty	Co-operation on scientific research & technological development	22. 10. 1969
KFK – Comisión Nacional de Energia Atómica	Individual agreement	Peaceful utilisation of nuclear energy	29. 7. 1971
DFVLR – Departamento de Investigación y Desarollo de la Fuerza Aérea Argentina (DID)	Individual agreement	Aero-Space research	15. 4. 1975
DFVLR – Comisión Nacional de Investigaciones Espaciales (CNIE)	Individual agreement	Wind energy, solar energy, space research	1. 11. 1978
BMI – Comisión Nacional de Energia Atómica	Agreement	Exchanges of technical information & co-operation in the sphere of safety at nuclear installations	8. 10. 1981
Australia			
Governments	Treaty	Scientific & technological co-operation	25. 10. 1976

Co-signatories	Nature of agreement	Substance	in force since
Austria			
BMFT – Ministry of Science & Research	Correspondence	Co-operation in the sphere of information & documentation	15. 9. 1980
Belgium			
Governments Belgian & Dutch	Memorandum	Fast breeder reactors	24. 1. 1967 (Belgium) 13. 7. 1967 (Netherlands)
Governments	Treaty	Subterranean gasification of coal	22. 12. 1977
Brazil			
Governments	Outline treaty	Co-operation on scientific research & technological development	12. 8. 1969
KFA – Comissao Nacional de Energia Nuclear (CNEN)	Individual agreement	Research into nuclear energy & technological development	23. 4. 1971
KFA – CNEN – Companhia Brasileira de Tecnologia Nuclear (CBTN)	Additional agreement	Integration of CBTN in the agreement of 23. 4. 1971	3. 10. 1973
DFVLR – Centro Técnico Aerospacial (CTA)	Individual agreement	Aero-Space research	18. 11. 1971
KFA – Conselho Nacional de Pesquisas (CNPq)	Individual agreement	Scientific & technical research except for nuclear energy, aerospace travel, mathematics & data-processing	19. 11. 1971
GMD – CNPq – Secretaria Especial de Informática (SEI)	In addition to the GMD/CNPq agreement of 7.6.72	Data processing, information studies	1. 4. 1981

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Co-signatories	Nature of agreement	Substance	in force since
GMD – CNPq	Individual agreement	Mathematics & data-processing	7. 6. 1972
GMD – CNPq Commissao de Coordenaçao de Atividades de Processamento Eletrónico (CAPRE)	Additional agreement	Integration of CAPRE in the agreement of 7. 6. 1972	24. 7. 1974
KFA – Empresas Nucleares Brasileiras. S.A. (NUCLEBRAS)	Individual-agreement	Utilisation of nuclear energy	3. 10. 1973
Governments	Treaty	Co-operation in the peaceful utilisation of nuclear energy	18. 11. 1975
DAAD – CNPq	Individual agreement	Exchange of highly-qualified scientists for research purposes	8. 8. 1976
Kiel Institute of Oceanography – Diretoria de Hidrografia e Navegaçao, do Ministério da Marinha (DHN)	Individual agreement	Marine sciences	1. 10. 1976
KfK – NUCLEBRAS	Individual agreement	Research into nuclear energy	1. 10. 1976
KFA – KWU – NUCLEBRAS	Individual agreement	R & D programme for utilising nuclear process heat in coal gasification	8. 3. 1978
KfK – CNEN	Individual agreement	Peaceful utilisation of nuclear energy	8. 3. 1978
KFA – Secretaria de Tecnologia Industrial do Ministério da Industria e Comércio (STI)	Individual agreement	Industrial technology	8. 3. 1978

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Co-signatories	Nature of agreement	Substance	in force since
BMI – Ministério de Minas e Energia (MME)	Agreement	Exchange of technical information & co-operation in the sphere of safety at nuclear installations	10. 3. 1978
BMI – MME	Agreement	Extension of the agreement of 10. 3. 1978	27. 7. 1983
KFA – NUCLEBRAS	Agreement	Utilisation of thorium in pressurized-water reactors	20. 3. 1979
KFA – Companhia Auxiliar de Empresas Elétricas Brasileiras (CAEEB)	Individual agreement	Coal utilisation & MARKAL energy model	11. 12. 1981
Canada			
Governments	Treaty	Co-operation on the peaceful utilisation of atomic energy	18. 12. 1957
Governments	Treaty	Scientific & technological co-operation	30. 6. 1971
Chile			
Governments	Treaty	Co-operation on scientific research & technological development	23. 10. 1970
China			
MPG – Chinese Academy of Sciences	Agreement	Basic research	15. 9. 1978
MPG – Chinese Academy of Sciences	Agreement	Extension of the agreement of 15. 9. 1978	29. 9. 1981
Governments	Treaty	Scientific & technological co-operation	10. 11. 1978
FhG – Chinese Academy of Sciences	Individual agreement	Applied research	11. 6. 1979
BMFT – State Commission for Science and Technology	Treaty	Implementation of a joint energy study	20. 11. 1979
BMFT – State Commission for Science and Technology	Treaty	Co-operation in the sphere of research into raw materials & industrial processing	20. 11. 1979

Co-signatories	Nature of agreement	Substance	in force since
BMFT – Ministry of Metallurgy	Treaty	Co-operation in the sphere of ore extraction, processing, & metallurgy	20. 11. 1979
BMFT – Ministry for the Oil Industry	Treaty	Implementation of a joint research project on the hydrocarbon potential of a deep in the Liny Basin	20. 11. 1979
BMFT – Ministry of Geology	Treaty	Co-operation in the search for carbohydrate substances in the East China Sea	20. 11. 1979
DFVLR – Chinese Aeronautical Establishment (CAE)	Individual agreement	Research in civil aviation	15. 4. 1980
BMFT – State Commission for Science & Technology	Treaty	Solar energy pilot project for the utilisation of regenerative sources of energy in supplying rural areas	26. 3. 1981
GMD – Chinese Academy of Sciences	Individual agreement	Information technology & applied spheres	15. 11. 1981
BMFT – Ministry for the Electronics Industry	Treaty	Co-operation on radio navigation systems in civil aviation	3. 1. 1983
BML – Ministry of Agriculture	Agreement	Scientific & technological co-operation on agricultural research	23. 11. 1983
Egypt			
Governments	Treaty	Co-operation on scientific research & technological development	20. 2. 1980
KFA – Academy of Scientific Research & Technology	Individual agreement	Scientific research & technological development	23. 4. 1980
Governments	Treaty	Co-operation in the sphere of peaceful utilisation of nuclear energy	15. 3. 1982

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Co-signatories	Nature of agreement	Substance	in force since
KFA – Qattara Hydro & Renewable Energy Project Authority	Individual agreement	Scientific research & technological development in the sphere of renewable sources of energy	20. 7. 1982
France			
Governments	Treaty	Construction, launching, & operation of the SYMPHONIE communications satellite	10. 11. 1967
BMFT – Centre National pour l'Exploitation des Océans	Treaty	Discovery, mining, & processing of manganese	26. 4. 1974
BMFT – Ministère de l'Industrie et de la Recherche	Treaty	Advanced reactor systems	13. 2. 1976
BMFT – ERDA/ Commissariat à l'Energie Atomique (CEA)/Swiss Office for Science and Research (AWF)	Agreement	Concepts & technologies for gas-cooled reactors	30. 9. 1977
BMFT – Commissariat à l'Energie Atomique	Treaty	Co-operation & exchanges in research into the safety of light-water reactors	28. 9. 1978
Governments	Treaty	Technical & industrial co-operation on radio satellites	1. 12. 1980
Governments	Treaty (Exchange of notes)	Joint export of radio satellites	22. 9. 1981
MPG – Centre National de la Recherche Scientifique	Individual agreement	Co-operation on scientific research	15. 6. 1981
Great Britain			
Governments British & Dutch	Treaty	Development & utilisation of a gas centrifuge process for producing enriched uranium	19. 7. 1971
BMFT – Science & Engineering Research Council (SERC)	Agreement	Active magnetospheres-plasma experiment with trace ions	17. 10. 1983

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Co-signatories	Nature of agreement	Substance	in force since
BMFT – SERC	Agreement	X-ray satellite project	17. 10. 1983
Greece			
BMFT – Ministry of Co-ordination	Treaty	Solar energy	5. 10. 1978
BMFT – Ministry of Co-ordination	Outline agreement	Scientific & technical co-operation	30. 11. 1978
BMFT – Ministries of Co-ordination & Labour	Treaty	Rational energy utilisation & deployment of solar resources	21. 2. 1983
India			
Governments	Treaty	Co-operation on peaceful utilisation of nuclear energy & on space research	19. 5. 1972
KFA – Department of Atomic Energy (DAE)	Individual agreement	Nuclear energy technology	6. 2. 1974
Governments	Agreement	Co-operation on scientific research & technological development	7. 3. 1974
DFVLR – Indian Space Research Organisation (ISRO)	Individual agreement	Space research	12. 8. 1974
KFA – Council for Scientific & Industrial Research (CSIR)	Individual agreement	Scientific research & technological development	25. 11. 1974
GSF – Indian Council for Medical Research (ICMR)	Individual agreement	Medical & biological research & development	2. 2. 1976
Indonesia			
Governments	Treaty	Co-operation on the peaceful utilisation of nuclear energy & prospecting for uranium	24. 2. 1977
Governments	Treaty	Co-operation on scientific research & technological development	6. 11. 1979

Co-signatories	Nature of agreement	Substance	in force since
DFVLR – National Institute for Aeronautics & Space (LAPAN)	Individual agreement	Long-distance reconnaissance, communications, & wind energy	10. 4. 1980
Rhineland Technical Monitoring Office – Badan Pengkajian Dan Penerapan Teknology (BPPT)	Individual agreement	Solar village project	7. 7. 1981
KFA – BPPT	Individual agreement	Bio-protein from cassava	5. 7. 1982
KFA – BPPT	Individual agreement	Energy research	20. 9. 1982
KFA – Badan Tenaga Atomic Nasional (BATAN)	Individual agreement	Peaceful utilisation of nuclear energy	29. 10. 1982
Iran			
Governments	Treaty	Co-operation on scientific & technological development	21. 11. 1977
BMFT – Atomic Energy Organisation of Iran	Treaty	Co-operation on peaceful utilisation of nuclear energy	21. 11. 1977
KfK – Atomic Energy Organisation of Iran	Individual agreement	Nuclear energy	11. 4. 1977
DFVLR – Arya-Mehr University of Technology, Teheran	Individual agreement	Space research	14. 1. 1978
Iraq			
Governments	Treaty	Economic, scientific, & technical co-operation	15. 7. 1981

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Co-signatories	Nature of agreement	Substance	in force since
Israel			
BMFT – National Council for Research & Development	Exchange of letters	Establishment of a joint committee for promotion of co-operation in scientific research & technological development	6. 8. 1973
BMFT-Minister for Science & Development	Treaty	Establishment of a foundation for scientific research & development	4. 7. 1986
Japan			
Governments	Treaty	Scientific & technological co-operation	8. 10. 1974
BMFT – Japan Atomic Energy Research Institute (JAERI)/US Nuclear Regulatory Commission (USNRC)	Agreement	Research into safety factors in the cooling of pressurized-water reactors	18. 4. 1980
Kuwait			
Governments	Treaty	Scientific & technological co-operation	4. 11. 1980
GKSS – Institute for Scientific Research, Kuwait (KISR)	Individual agreement	Reversed osmosis pilot unit	4. 3. 1979
Mexico			
Governments	Outline treaty	Scientific & technological co-operation	4. 9. 1975
GSF – Instituto Politécnico Nacional (IPN)	Individual agreement	Co-operation on scientific research & technological development in biology & medicine	22. 9. 1975
BMFT – Secretaria de Asentamientos Humanos y Obras Públicas de los Estados Unidos de Mexico (SAHOP)	Special agreement	Co-operation on R & D in the utilisation of solar energy	2. 5. 1978
KfK – Instituto Nacional de Investigaciones Nucleares (ININ)	Individual agreement	Nuclear energy	4. 12. 1981

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Co-signatories	Nature of agreement	Substance	in force since
BMFT – Secretaría de Patrimonio y Fomento Industrial (SEPAFIN)	Individual agreement	Co-operation on the evaluation, development, & application of environmentally acceptable techniques of production	10. 2. 1982
Netherlands			
Governments Belgian & Dutch	Memorandum	Fast-breeder reactors	24. 1. 1967 (Belgium) 13. 7. 1967 (Netherlands)
Governments British & Dutch	Treaty	Development & utilisation of a gas centrifuge process for producing enriched uranium	19. 7. 1971
BML – Ministry of Agriculture & Fisheries	Agreement	Co-operation in the sphere of agricultural research	30. 4. 1968
New Zealand			
Governments	Treaty	Scientific & technological co-operation	23. 8. 1978
Governments	Agreement	Scientific co-operation in the Antarctic	26. 6. 1981
Pakistan			
Governments	Treaty	Co-operation on scientific research & technological development	15. 10. 1973
KfK – Pakistan Atomic Energy Commission	Individual agreement	Peaceful utilisation of nuclear energy	25. 6. 1974
Portugal			
Governments	Treaty	Co-operation on scientific research & technological development	21. 9. 1981
BMFT – Ministry of Industry	Agreement	Establishment & operation of a solar process-heat unit	16. 12. 1981
Rumania			
Governments	Treaty	Co-operation on scientific research & technological development	29. 6. 1973
BMFT – State Committee on Nuclear Energy	Treaty	Co-operation on the peaceful utilisation of nuclear energy	29. 6. 1973

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Co-signatories	Nature of agreement	Substance	in force since
Karlsruhe University Geophysical Institute – Institute for Hydro-electric Studies, Bucharest	Individual agreement	Research into earthquakes	1. 6. 1977
KfK – State Committee for Nuclear Energy	Individual agreement	Peaceful utilisation of nuclear energy	10. 2. 1976
BML – Ministry of Food & Agriculture	Treaty	Scientific & technical co-operation	16. 10. 1973
Saudi-Arabia			
Governments	Treaty	Co-operation on scientific research & technological development	24. 3. 1982
BMFT – Saudi Arabian National Centre for Science & Technology	Exchange of letters	Guidelines for the implementation of joint projects	12. 7. 1982
Spain			
Governments	Outline agreement	Co-operation on scientific research & technological development	10. 3. 1971
Governments	Treaty	Establishment & operation of the "German-Spanish Astronomical Centre"	21. 5. 1973
MPG – National Commission for Astronomy	Individual agreement	Establishment & operation of the "German-Spanish Astronomical Centre"	21. 5. 1973
KfK – Junta de Energia Nuclear (JEN)	Individual agreement	Peaceful utilisation of nuclear energy	27. 7. 1973
Governments	Treaty	Co-operation in the sphere of utilisation of nuclear energy	13. 12. 1978
Governments	Treaty	Co-operation on solar energy	13. 12. 1978
Governments	Treaty	Co-operation on radio-astronomy	3. 8. 1981

Co-signatories	Nature of agreement	Substance	in force since
DFVLR – INTA	Individual agreement	Aero-Space research	in preparation
BML – Ministry of Agriculture	Treaty	Scientific & technical co-operation in the sphere of agriculture	22. 10. 1979
Switzerland			
KFA – Swiss Institute for Reactor Research (EIR)	Individual agreement	Swiss participation in a development programme for a power station with high-temperature reactor & helium turbine (HHT)	1. 9. 1973
KfK – Swiss Institute for Nuclear Research (SIN)	Individual agreement	Utilisation of SIN installations by groups of German researchers	1. 1. 1977
BMFT – ERDA/ Commissariat à l'Energie Atomique (CEA)/Swiss Office of Science & Research (AWF)	Agreement	Concepts & technologies for gas-cooled reactors	30. 9. 1977
BMFT – Swiss Federal Office of Energy	Exchange of letters	Co-operation in the sphere of reactor safety	3. 4. 1982
BMFT – Swiss Federal Office for Education & Science	Exchange of letters	Co-operation on safe storage of radioactive waste (Grimsel rock laboratory project)	24. 2. 1983
USA			
BMFT – National Aeronautics & Space Administration (NASA)	Agreement	Implementation of a project for an aeronomy satellite	10. 6. 1969
BMFT – NASA	Agreement	Implementation of the HELIOS solar probe project	10. 6. 1969
BMFT – Dept. of the Interior	Agreement	Co-operation in the sphere of magneto-hydrodynamic energy-conversion	21. 4. 1971
BMFT/BMV – Dept. of Transportation (DOT)	Agreement	Co-operation on the development of advanced ground transportation, particularly high-speed tracked systems	12. 6. 1973

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Co-signatories	Nature of agreement	Substance	in force since
BMFT/BMV – DOT	Agreement	Extension & modification of the 12. 6. 1973 agreement	30. 8. 1978
BMFT – Atomic Energy Commission (AEC)	Agreement	Technical exchanges & co-operation on R & D in the sphere of reactor safety	6. 3. 1974
BMFT – United States Nuclear Regulatory Commission (USNRC)	Agreement	Extension of the 6. 3. 1974 agreement with the AEC	8. 3. 1983
Governments	Treaty	Co-operation on environmental issues	26. 3. 1975
BMFT – AEC	Agreement	Technical exchanges & co-operation in the sphere of handling & elimination of radioactive waste	20. 12. 1974
BMFT – Dept. of Energy (DOE)	Agreement	Amendment of the existing 20. 12. 1974 agreement with the AEC	19. 3. 1980
BMFT – Energy Research & Development Administration (ERDA)	Agreement	Natrium-cooled fast-breeder reactors	8. 6. 1976
BMFT – Dept. for Health, Education & Human Welfare (DHEW)	Agreement	Bio-medical research & development	22. 9. 1976
BMFT – Dept. of Health & Human Services (DHHS)	Exchange of letters	Extension of the 22. 9. 1976 agreement with the DHEW	22. 9. 1981 (retrospective)
BMFT – ERDA	Agreement	Concepts & technologies for gas-cooled reactors	11. 2. 1977
BMFT – ERDA	Agreement	Safety measures & the physical protection of nuclear materials & installations	29. 9. 1977
BMFT – ERDA/ Commissariat à l'Energie Atomique (CEA)/Swiss Office of Science & Research (AWF)	Agreement	Concepts & technologies for gas-cooled reactors	30. 9. 1977

Co-signatories	Nature of agreement	Substance	in force since
BMFT – NASA	Agreement	BMFT participation in NASA's "Jupiter Orbiter and Probe" project	5. 10. 1977
BMFT – DOT	Agreement	Co-operation on the development of national air safety systems	20. 8. 1979
BMFT – DOE	Agreement	Project for converting methyl into petrol	20. 3. 1980
BMFT – Japan Atomic Energy Research Institute (JAERI)/USNRC	Agreement	Research into safety factors during the cooling of pressurized-water reactors	18. 4. 1980
BMFT – Environmental Protection Agency (EPA)	Agreement	Co-operation on the development & demonstration of technology for regulation of the environment in energy systems	2. 5. 1980
BMFT – NASA	Agreement	Utilisation of space transportation systems	30. 6. 1981
BMFT – DOE	Special agreement	Experiments in the Asse salt mine	1. 10. 1981
BMFT – NASA	Agreement	Active magnetospheres plasma experiment with trace elements (AMPTE)	15. 10. 1981
BMFT – NASA	Agreement	X-ray satellite	8. 8. 1982
BMFT – Electric Power Research Institute (EPRI)	Agreement	Co-operation in the sphere of energy research & reactor safety	10. 9. 1982
BML – Dept. of Agriculture	Agreement	Co-operation in the sphere of agricultural science & technology	1. 6. 1981
Venezuela			
Governments	Agreement	Co-operation on science & technology	28. 12. 1978
BMFT – Ministry of Energy & Mining	Special agreement	Technical co-operation in the energy sphere	16. 10. 1978

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Co-signatories	Nature of agreement	Substance	in force since
Yugoslavia			
BMFT – Federal Office for International Co-operation in Science, Education, Culture, & Technology	Agreement	Co-operation on scientific research & technological development	23. 5. 1975
KFA – Federal Office for International Co-operation in Science, Education, Culture, & Technology	Individual agreement	Scientific research & technological development	8. 7. 1977

Key

BMFT – Federal Ministry of Research & Technology
BMI – Federal Ministry of the Interior
BML – Federal Ministry of Food, Agriculture, & Forestry
BMV – Federal Ministry of Transport
DAAD – German Academic Exchange Service
DFVLR – German Aero-Space Research & Experimental Unit, Porz
FhG – Fraunhofer Society for the Promotion of Applied Research e. V.
GKSS – Society for the Utilisation of Nuclear Energy in Ship-Building & Navigation mbH, Hamburg
GMD – Society for Mathematics & Data-Processing mbH, Birlinghoven
GSF – Society for Research into Radiation & the Environment mbH, Neuherberg
KFA – Nuclear Research Unit, Julich
KfK – Nuclear Research Centre GmbH, Karlsruhe
MPG – Max Planck Society

Source: Federal Research Report 1984 with complement

Table 12

Federal German membership of international organisations and research facilities

International organisations

European Space Agency (ESA), Paris

International Atomic Energy Organisation (IAEO), Vienna

Inter-Governmental Oceanographic Commission (IOC), Paris

North Atlantic Treaty Organisation (NATO), Brussels: Science & Environment Committee, & Defence Research Group

Organisation for Economic Co-operation & Development (OECD), Paris

United Nations Educational, Scientific, and Cultural Organisation (UNESCO), Paris

United Nations Institute for Training & Research (UNITAR), New York

International research facilities

European Centre for Nuclear Research (CERN), Geneva
German-Dutch Wind Tunnel Foundation (DNW), Emmeloord/Netherlands
European Organisation for Astronomical Research in the Southern Hemisphere (ESO), Garching
European Molecular Biology Conference (EMBC) – European Molecular Biology Laboratory (EMBL), Heidelberg
European Community Joint Research Centres (GFS) at Ispra, Karlsruhe, Geel, and Petten
European Medium-Range Weather-Forecasting Centre (EZMW), Shinfield Park, near Reading, Great Britain
International Institute for Applied Systems Analysis (IIASA), Vienna
Max von Laue-Paul Langevin Institute (ILL), Grenoble
Franco-German Research Institute Saint-Louis (ISL), Saint Louis
European University Institute Florence (EHJ), San Dominico di Fiesol
Consultative Group on International Agricultural Research (CGIAR), Washington

Source: Federal Research Report 1984

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II. *Organisations Mediating Exchanges*

1. The Alexander von Humboldt Foundation (AvH)

The Foundation's charter lays down that the organisation's aim is to award research fellowships and prizes to highly qualified persons of foreign nationality, regardless of their sex, race, religion, or ideology, giving them an opportunity to implement a research project in the Federal Republic of Germany and to maintain the academic contacts which result. The Foundation today receives over 90% of its funds from public sources, principally the German Foreign Office's cultural fund, the Federal Ministries of Research and Technology, of Education and Science, and of Economic Co-operation, other foundations, and the Donors' Association.
A year after the death of Alexander von Humboldt in 1859, the Alexander von Humboldt Foundation for Scientific Research and Travel was established in Berlin under the auspices of the Prussian Academy of Sciences so as to help German scholars – following in Humboldt's footsteps – undertake research travels abroad. The Foundation went bankrupt in 1923 during the economic depression after World War I. Two years later the Alexander von Humboldt Foundation was re-established by the Republican authorities with the task of inviting highly-talented students to come to Germany. These activities were pursued until 1945. It was set up again – on the instigation of foreign scholars – by the Federal Republic of Germany in 1953 as a public foundation under civil law with its headquarters in Bonn.
Selection of candidates is not limited by any quotas for specialisations or countries. The decisive criterion is the applicant's scholarly qualification. After completion of university studies, the applicant must have spent several years in research at a university in his or her home country. He or she must also submit a detailed outline of the proposed research project. Applications can be submitted at any time, either directly to the Foundation, or by way of German university teachers, the Federal Republic's diplomatic or consular representatives, and foreign branches of the German Academic Exchange Service (P 96). The Foundation's selection committee includes around 100 well-known German scientists representing all disciplines.
The Foundation has never striven to increase to any great extent the number of foreign scholars assisted. Ten years ago there were around 450, and today no more than 500 stipendia are awarded annually. By now there are over 10,000 former Humboldt Research Fellows or guest scholars from 93 nations, and the Foundation maintains active contact with

most of them. It also re-invites a limited number to the Federal Republic for short stays on scholarly business. In addition it can provide former Research Fellows from countries with foreign exchange problems with equipment and books assisting continuation of work started in Germany. These personal links with Research Fellows are a crucial element in the Foundation's success and high reputation.

The Alexander von Humboldt Foundation also administers a special programme set up by the Federal Republic where up to 80 established American scientists, engineers, and doctors receive Humboldt Awards each year for their contributions to research. This programme was launched on June 5, 1972 at Harvard University by the then German Federal Chancellor, Willy Brandt, in conjunction with the setting up of the "German Marshall Fund" as an expression of gratitude to the American people for the help towards German reconstruction provided in the Marshall Plan after the Second World War. Around 7 million DM are made available annually by the Federal Ministry of Research and Technology so that American scientists can pursue their interests at German research institutes over a longer period. That also promotes co-operation between universities and other research centres in the USA and the Federal Republic of Germany. Up to now over 1,000 internationally recognised American scientists have received Humboldt Awards. The Humboldt Foundation also maintains contact with these people.

The Foundation's Feodor Lynen programme, established in 1979 and endowed with over two a million DM each year by the Federal Ministry of Education and Science, is devoted to sending 30 young German academics each year to foreign institutes where they are looked after by former Humboldt Research Fellows. Over 270 young Germans have to date made successful use of such assistance, including an annual total of up to 10 researchers financed by the Japan Society for the Promotion of Science (JSPS, Tokyo).

There are two other special programmes: the research prizes for foreign scholars in the humanities established by the Volkswagenwerk Foundation in 1979, and the Franco-German Prize (awarded annually to 3 Germans and 3 French scholars) agreed at the 1981 Paris Summit of EEC Heads of Government.

2. The German Academic Exchange Service

The German Academic Exchange Service (Deutscher Akademischer Austauschdienst – DAAD) was founded in 1925 as an organisation serving German universities, and was re-established in 1950. Its task is to promote university relations – particularly exchanges of scholars – between the Federal Republic of Germany and other countries.

Like many of the organisations involved in assisting scholarship in the Federal Republic of Germany, the Academic Exchange Service is a registered company in civil law. The universities constitute its members. Fulfilment of its functions is, however, primarily dependent on public funds being made available by the German Foreign Office, the Federal Ministry of Education and Science, and the Federal Ministry of Economic Co-operation. The Laender provide additional funds, and also make an essential contribution by way of the co-operation of university teachers and the provision of study-places for foreigners. The main source of private assistance for the DAAD is the Donors' Association for the Promotion of Sciences and Humanities.

Scholars, professors, and students in all faculties including the arts come from almost every country in the world to participate in the DAAD-assisted foreign programmes at universities and Fachhochschulen.

The largest individual programme covers the awarding of grants to foreign students and young scientists – usually for a year's work at a German university. These scholarships mainly go to applicants who have already graduated in their home countries. The scholarship is meant to make possible advanced studies and specialisation. Applicants from the developing countries often work for doctorates too. If the scholarship-holder is making good progress and if the objective at issue demands this, the stipendium can be extended accordingly. Only in exceptional cases though does the German Academic Exchange Service give fellowships to applicants who want to pursue their entire course of studies in the Federal Republic of Germany. Preliminary selection is carried out by a bi-national commission in the applicant's home country, and the final decision is taken in Bonn by a specialised committee of scientists.

Alongside the annual scholarships, which are open to applicants in all subjects from all countries, there are a number of special programmes for specific countries or specialisations – such as for Germanists from France, for pupils who complete courses at German schools abroad, and for training African teachers of German in the Francophone states of Africa. The DAAD also gives foreign students stipendia for shorter stays in this country so that they can, for instance, collect information for an examination

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paper or take part in a vacation or language course in the Federal Republic of Germany. Finally, the DAAD provides German universities with funds for contact scholarships (for foreign students from partner universities), and gives subsidies for parties of foreign students who want to visit German facilities within their specialisation and to cultivate contacts with German colleagues.

The DAAD assistance measures play a very crucial part in the programmes of educational and scientific aid forming part of agreements between the Federal Government and foreign governments or universities. The DAAD supports the development and expansion of universities and research institutes in Latin America, Asia, and Africa, and the training of young scholars in these regions' national universities (Sur-Place Stipendia), on the basis of co-operation in partnership. It also provides assistance for exchanges of guest professors between foreign and German universities, and for close links between universities in the Federal Republic and the other industrial countries.

In recent years the DAAD has increasingly also taken on the organisation of training programmes for students and young scholars. These are financed by their government or a national research organisation (Government Awards Programme).

The range of assistance offered by the German Academic Exchange Service for German students and young scholars is equally diverse. There are annual fellowships at foreign universities for graduates, and assistance for such special programmes as those for specialists in English in North America, Great Britain, and Ireland, for specialists in French in France, and also for smaller groups within a university faculty which study for a term or a year at a partner university. There are also special programmes for learning Far Eastern languages, and limited grants for collecting research material or language courses. Foreign governments, foundations, and universities often offer their scholarships for Germans by way of the DAAD, which then selects the recipients of awards.

Foreign scientists and university teachers can be invited to the Federal Republic by the DAAD for study periods of between one and three months, and a number of agreements with foreign governments or scientific organisations provide for regular exchanges of professors by way of the German Academic Exchange Service. At the request of foreign universities – particularly from the Third World – the DAAD mediates German university professors for short- or long-term appointments abroad, helping in the development of specific courses and faculties. The 400 or so lecturers in the German language, literature, and national studies, who work at universities all over the world, constitute a special group among

the scholars that are thus mediated.
Students in the faculties of engineering and the natural sciences have the possibility of taking part through the DAAD in the activities organised by the International Association for the Exchange of Students for Technical Experience. The DAAD here enables German and foreign students to gain practical experience during their summer vacations in industrial firms, service enterprises, and research institutes. The DAAD also provides assistance for the work of organisations that arrange similar exchanges for doctors (West German Medical Exchanges) and experts in applied economics (Association Internationale des Etudiants en Sciences Economiques et Commerciales).
The Berlin Artists in Residence Programme constitutes a special aspect of the DAAD's activities. Every year the DAAD invites around 25 well-known younger sculptors, painters, writers, and composers from abroad to spend between 6 and 12 months in Berlin (West). They are given an opportunity to pursue their work and to play an active part in cultural life in the city.
The extent of the assistance provided by the DAAD is also apparent in the statistics. Every year some 3,300 foreign and 1,900 German students and graduates receive a fellowship covering either a semester or a year. Around 3,800 German and foreign students are given DAAD help towards practical studies during the summer months, and some 1,600 German and around 2,000 foreign university teachers take part in some from of exchange or are mediated teaching posts at foreign universities. The DAAD's overall annual budget amounts to around 160 million DM. The DAAD's far-ranging sphere of activity is completed by the making available of comprehensive documentation and information about possibilities of study, teaching, and research in Germany and other countries. This also involves answering many individual enquiries from government and university departments, and from individuals at home and abroad.
The DAAD has established external branches in a number of countries with which relations are particularly comprehensive. Such branches were initially opened in London, New Delhi, Cairo, Paris, and New York, and these were followed by offices in Rio de Janeiro, Nairobi, and Tokyo.

3. The Fulbright Commission

The "Commission for Educational Exchange between the United States of America and the Federal Republic of Germany" (Fulbright Commission) is a bi-national institution for promoting and supporting academic

and educational exchanges. Its activities were originally based on a 1952 agreement signed by the then Chancellor Dr. Konrad Adenauer and the American High Commissioner John McCloy, and are now operated under the Executive Agreement of 1962. Both governments supervise and fund the exchange programme. The German financial contribution is provided by the Foreign Office and (for the "Fachhochschul" Programme) from a special allocation by the Federal Ministry of Education and Science.

The regular grant programme encompasses academic exchanges for students, research scholars, and faculty members, as well as exchange teachers from all types of elementary and secondary schools and experts from certain professional areas (e.g. educational administration/planning, foreign student offices, libraries, museums). Special programms are being conducted for U.S. faculty in the field of German Studies and for German teacher trainers in the area of American Studies. In its regular programme the Commisson sponsors about 300 American and 400 German grantees annually.

The programme for Fachhochschulen has developed from a pilot project initiated in 1972 and currently comprises up to 60 students and graduates from all disciplines, primarily from informatics (computer science), engineering, management/industrial engineering, social work/human services. This programme is of particular significance with regard to higher education politics because the Fachhochschulen have been expressly integrated in the general promotion of study abroad. As complementary measures towards this objective the Commission places American grantees at Fachhochschulen and it includes administrators and faculty from these institutions in professional exchanges in order to facilitate and strengthen transatlantic ties over and beyond this special programme into the future.

In addition to its grant programme the Commission provides special services in the Federal Republic and the U.S.A. such as advice and information for public and private institutions, student counseling, and assistance to other organisations in planning and implementing bilateral projects.

The Commission operates within a worldwide framework of 44 similar Fulbright programmes in which the U.S. is the partner.

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E. Appendix

I. *Institutions of Higher Education in the Federal Republic of Germany*

1. Universities and Colleges – Wissenschaftliche Hochschulen[1]

Land / Institution		Staff[2] total	Staff[2] academic staff	German & Foreign students[3]
Baden-Württemberg				
U	Heidelberg	8,315	2,405	26,599
U	Tübingen	7,448	2,075	22,735
U	Freiburg	7,682	1,890	22,129
U	Stuttgart (TC)	3,575	1,667	17,532
U	Karlsruhe (TC)	3,598	1,656	17,315
U	Ulm	4,020	1,005	4,511
U	Constance	1,408	605	5,967
U	Hohenheim	1,574	557	5,079
U	Mannheim	813	421	10,314
CE	Heidelberg	238	155	1,876
CE	Freiburg	221	146	2,106
CE	Ludwigsburg	210	143	1,683
CE	Weingarten	147	104	864
CE	Karlsruhe	166	103	979
CE	Reutlingen	192	95	1,205
CE	Schwäbisch-Gmünd	144	89	702
College of Vocational Education				
	Stuttgart (Esslingen)	72	44	370
U	College of Jewish Studies			
	Heidelberg	15	10	43

[1] According to Laender & listed in order of numbers of academic staff
[2] Staff figures in 1984 (full-time personnel)
[3] Winter semester 1985/86

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Land		Staff[2]		German & foreign students[3]
Institution		total	academic staff	
Bavaria				
U	Munich	12,456	3,569	56,999
TU	Munich	7,330	2,404	21,822
U	Erlangen-Nuremberg	6,891	1,882	23,991
U	Würzburg	5,920	1,459	16,763
U	Regensburg	1,961	913	11,277
CU	Federal Army College Neubiberg	1,023	463	3,013
U	Bayreuth	970	456	4,793
U	Augsburg	821	402	7,214
U	Bamberg	548	263	4,470
U	Passau	444	197	4,093
U	Eichstätt	376	181	2,132
U	Church College of Philosophy, Munich	34	24	376
CU	Neuendettelsau (Prot)	57	19	305
U	College of Philosophy & Theology Benediktbeuren	27	16	113
Berlin				
Free U	Berlin	15,104	4,061	52,708
TU	Berlin	5,432	2,480	25,647
U	Church College Berlin	58	28	579
Bremen				
U	Bremen	1,775	724	8,680
Hamburg				
U	Hamburg	9,986	3,070	41,430
U	Hamburg Federal Army College	719	318	2,120
U	Hamburg-Harburg (TU)	463	179	350
U	College of Economics & Politics	146	88	1,860

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Land		Staff[2]		German & Foreign students[3]
Institution		total	academic staff	
Hesse				
U	Frankfurt	7,345	2,208	29,195
U	Gießen	7,416	1,887	16,308
U	Marburg	6,359	1,598	14,800
U	Darmstadt (TC)	3,304	1,393	14,108
CU	Kassel	1,676	714	9,245
U	College of Philosophy & Theology St. Georgen	41	30	342
U	College of Philosophy & Theology Fulda	16	11	56
U	Lutheran Theological College Oberursel	12	7	103
Lower Saxony				
U	Göttingen	10,292	2,650	28,802
U	Hanover	3,425	1,795	24,862
U	Brunswick (TU)	2,894	1,194	14,723
U	Medical College Hanover	5,389	891	3,613
U	Clausthal (TU)	1,201	527	3,712
U	Osnabrück	1,088	473	7,421
U	Oldenburg	1,164	448	9,157
U	Veterinary College Hanover	945	249	1,969
U	Hildesheim	209	117	1,800
U	Lüneburg	204	98	1,538

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Land		Staff[2]		German &
Institution		total	academic staff	Foreign students[3]
North Rhine-Westphalia				
TU	Aachen	9,504	2,971	34,395
U	Münster	8,410	2,461	43,585
U	Bonn	7,635	2,295	39,395
U	Cologne	7,544	2,067	46,033
U	Bochum	4,194	1,898	29,809
U	Essen (CU)	5,818	1,315	17,019
U	Düsseldorf	6,218	1,271	14,675
U	Dortmund	2,572	1,196	17,500
U	Bielefeld	2,137	1,022	13,221
U	Wuppertal (CU)	1,440	713	12,332
U	Paderborn (CU)	1,348	642	11,854
U	Siegen (CU)	1,200	570	7,832
U	Duisburg (CU)	1,163	527	10,399
	Open University Hagen (CU)	707	228	16,059
U	German Sports College Cologne	375	154	4,714
U	Theol. Faculty Paderborn	46	22	275
U	Church College Wuppertal	49	21	350
U	Church College Bethel	48	18	403
U	Witten-Herdecke (Private U)	18	5	147
U	College of Philosophy & Theology Münster	–	–	47
U	College of Philosophy & Theology St. Augustin	–	–	33
U	College of Philosophy & Theology Hennef-Sieg	–	–	18

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Land / Institution		Staff[2] total	Staff[2] academic staff	German & Foreign students[3]
Rhineland-Palatinate				
U	Mainz	7,379	2,055	25,337
U	Kaiserslautern	1,057	513	6,708
U	Trier	778	336	7,085
R-P.	Institute of Education	409	228	2,541
U	College of Administration Speyer	127	46	458
U	Theol. Faculty Trier	51	29	333
U	Theol. College (Cath). Vallendar	16	12	58
U	Koblenz (Private College of business management)	6	4	86
Saarland				
U	University Saarland	5,965	1,532	17,259
Schleswig-Holstein				
U	Kiel	6,934	1,856	17,221
U	Medical U Lübeck	2,708	444	1,094
CE	Kiel	167	113	1,644
CE	Flensburg	104	72	712

Key

CE – College of Education (Pädagogische Hochschule)
CU – Comprehensive University
TU/TC – Technical University/Technical College
U – University

Sources: Federal Ministry of Education & Science (Publisher): Reihe Grund- und Strukturdaten, Bonn
Federal Statistics Office, Wiesbaden (Publisher): Personal an Hochschulen 1984, in: Bildung und Kultur, Fachserie 11, Reihe 4.4, Mainz 1986.

2. Colleges of Art and Music[1]

Land / Institution	Staff[2] total	Staff[2] academic staff	German & Foreign students[3]
Baden-Württemberg			
Stuttgart (Music & Performing Arts)	99	78	805
Stuttgart (Academy of Fine Arts)	104	80	779
Freiburg (Music)	80	61	596
Heidelberg-Mannheim (Music)	47	34	541
Karlsruhe (Music)	38	28	436
Trossingen (Music)	47	31	428
Karlsruhe (Academy of Fine Arts)	59	34	263
Bavaria			
Munich (Music)	97	78	794
Munich (Academy of Fine Arts)	99	65	728
Würzburg (Music)	68	47	507
Nuremberg (Academy of Fine Arts)	40	29	295
Munich (Television & Film)	37	12	118
Berlin			
Berlin (Arts)	703	406	4,234
Bremen	see table I. 3		
Hamburg			
Hamburg (Fine Arts)	113	65	980
Hamburg (Music & Performing Arts)	118	82	600

[1] According to Laender & listed in order of numbers of students
[2] Staff Figures in winter semester 1984/85 (full-time personnel)
[3] Winter semester 1985/86

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Land Institution	Staff[2]		German & foreign students[3]
	total	academic staff	
Hesse			
Frankfurt (Music & Performing Arts)	91	60	664
Offenbach (Design)	53	31	467
Frankfurt (Fine Arts)	21	10	96
Lower Saxony			
Brunswick (Fine Arts)	141	45	962
Hanover (Music & Theatre)	130	98	830
North Rhine-Westphalia			
Rhineland College of Music[4]	216	153	2,736
Westfalen-Lippe College of Music[5]	140	94	1,418
Düsseldorf Art Academy[6]	124	74	887
Ruhr College of Music[7]	111	82	872
Saarland			
Saarbrücken (College of Music)	51	31	267
Schleswig-Holstein			
Lübeck (College of Music)	46	28	362

[4] Institutes at Aachen, Cologne, Düsseldorf, Wuppertal
[5] Institutes at Detmold, Dortmund, Münster
[6] Institute at Münster
[7] Institutes at Duisburg, Essen

Sources: Federal Ministry of Education & Science (Publisher): Reihe Grund- und Strukturdaten, Bonn
Federal Statistics Office, Wiesbaden (Publisher): Personal an Hochschulen 1984, in Bildung und Kultur, Fachserie 11, Reihe 4.4, Mainz 1986.

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3. Fachhochschulen[1]

Land / Institution	Staff[2] total	Staff[2] academic staff	German & foreign students[3]
Baden-Württemberg			
Karlsruhe	281	137	3,759
Heilbronn	162	96	2,732
Esslingen (Technology)	192	102	2,672
Pforzheim (Economics)	107	72	2,636
Constance	181	98	2,087
Aalen	147	81	2,030
Mannheim (Technology)	194	80	2,024
Stuttgart (Technology)	104	80	1,976
Reutlingen (Technology & Economics)	192	95	1,923
Ulm	132	70	1,785
Nürtingen	95	49	1,620
Furtwangen	121	60	1,498
Stuttgart (Public Administration EA)	60	43	1,211
Offenburg	91	46	1,194
Ravensburg-Weingarten	67	34	1,137
Stuttgart (Printing)	67	38	1,074
Kehl (Public Administration EA)	55	40	936
Freiburg (Cath. College for Social Studies & Religious Pedagogics)	58	31	882
Biberach	64	33	842
Ludwigsburg (Finance EA)	46	32	842
Esslingen (Social Studies)	43	24	675
Freiburg (Prot. College for Social Studies, Religious Pedagogics, & Community Welfare Work)	34	21	644

[1] According to Laender & listed in order of numbers of students
[2] Staff figures in 1984 (full-time personnel)
[3] Winter semester 1985/86

Land / Institution	Staff[2] total	Staff[2] academic staff	German & foreign students[3]
Sigmaringen (Technology)	33	21	619
Stuttgart (Librarianship)	40	28	583
Mannheim (Social Studies)	25	16	489
Reutlingen (Prot. College for Social Studies)	36	19	452
Rottenburg (Forestry EA)	29	14	440
Pforzheim (Design)	41	21	347
Schwetzingen (Law EA)	34	9	313
Villingen-Schwenningen (Police)	43	16	311
Isny (Private Academy of Science & Technology)	28	25	280
Heidelberg (Vocational Advancement)	45	39	260
Schwäbisch-Gmünd (Design)	33	19	260
Mannheim (Design)	23	10	191
Bavaria			
Munich	585	366	13,969
Nuremberg	366	204	6,775
Würzburg-Schweinfurt	264	123	5,229
Regensburg	225	127	4,795
Bavarian Civil Service Fachhochschule (EA)[4]	279	102	3,988
Augsburg	175	96	3,307
Rosenheim	193	84	3,152
Coburg[5]	209	79	2,633
Weihenstephan	312	64	2,053
Munich (Cath. Fachhochschule)	67	45	1,333
Kempten	57	27	1,298
Landshut	55	28	1,181
Nuremberg (Prot. Fachhochschule for Social Studies)	22	14	514

[4] Incl. sections at Fürstenfeldbruck, Herrsching, Hof, Munich, Starnberg, Wasserburg
[5] Incl. section at Münchberg

Land / Institution	Staff[2] total	Staff[2] academic staff	German & foreign students[3]
Berlin			
Berlin (Technology)	521	267	4,623
Berlin (Administration & Law EA)	97	40	1,517
Berlin (Economics)	79	39	1,377
Berlin (Social Work & Education)	78	46	778
Berlin (Fed. German Post office)	51	24	583
Berlin (Prot.)	51	24	475
Bremen			
Bremen[6]	440	205	3,973
Bremerhaven (C)	103	57	930
Bremen (Formative Arts & Music)	96	54	709
Bremen (Public Administration EA)	20	11	221
Hamburg			
Hamburg	489	475	12,200
Hamburg (Public Administration EA)	42	30	1,110
Hamburg (Prot. College for Social Pedagogics)	12	8	150

[6] Fachhochschule for Technology, social studies & economics, commerce, & nautical science integrated in Bremen University since 1982

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Land Institution	Staff[2]		German & foreign students[3]
	total	academic staff	
Hesse			
Darmstadt	384	217	6,550
Frankfurt	358	209	6,509
Gießen[7]	344	181	6,433
Wiesbaden[8]	607	196	5,561
Fulda	130	69	2,119
Wiesbaden (EA)	72	46	1,306
Dieburg (Fed. German Post Office)	189	77	881
Rotenburg (Administration)	112	36	701
Darmstadt (Prot.)	48	31	652
Oestrich-Winkel (Private European Business School)	35	11	466
Wiesbaden (Private Fachhochschule Fresenius)	18	11	223
Frankfurt (Librarianship EA)	6	4	96
Marburg (Archives EA)	6	3	26

[7] Incl. section at Friedberg
[8] Incl. sections at Geisenheim, Idstein, & Rüsselsheim

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Land / Institution	Staff[2] total	Staff[2] academic staff	German & foreign students[3]
Lower Saxony			
Hanover[9]	274	170	4,149
Osnabrück	285	144	3,773
Hildesheim-Holzminden	211	132	3,283
Brunswick-Wolfenbüttel	189	104	2,671
Hildesheim (Administration & Law EA)[10]	222	100	2,587
Wilhelmshaven	155	91	2,256
North-East Lower Saxony[11]	160	77	2,012
East Friesland[12]	131	67	1,488
Oldenburg[13]	110	63	1,083
Hanover (Prot.)	77	46	773
North Germany (Cath)[14]	38	25	441
Ottersberg (Private Fachhochschule for Art Therapy)	15	13	279
North Rhine-Westphalia			
Cologne[15]	523	392	16,183
Lower Rhine[16]	484	222	8,720
Münster[17]	515	245	8,467
Cologne (Federal Public Administration EA)[18]	548	338	7,984

[9] Incl. section at Nienburg
[10] Incl. sections at Hildesheim & Rinteln
[11] Incl. sections at Buxtehude, Lüneburg, Suderburg
[12] Incl. sections at Emden & Leer
[13] Incl. section at Elsfleth
[14] Incl. sections at Osnabrück & Vechta
[15] Incl. section at Gummersbach
[16] Incl. sections at Krefeld & Mönchengladbach
[17] Incl. section at Steinfurt
[18] Specialised sections at Berlin, Bonn, Cologne (2), Dieburg, Frankfurt, Mainz, Mannheim (2), Sigmaringen

Land Fachhochschule	Staff[2]		German & foreign students[3]
	total	academic staff	
Aachen[19]	504	198	7,534
Düsseldorf	331	174	7,396
Dortmund	378	195	7,138
Bochum[20]	367	158	5,758
Bielefeld[21]	370	184	5,642
North Rhine-Westphalia (Public Administration EA)[22]	192	106	3,971
Lippe[23]	141	111	3,907
Hagen[24]	279	107	3,693
North Rhine-Westphalia (Cath)[25]	167	94	2,618
Nordkirchen (Finance EA)	193	76	1,753
Rhineland-Westphalia-Lippe (Prot.)	67	43	1,243
Bochum (Private Mining Fachhochschule)	77	30	1,075
Cologne (Rhineland Fachhochschule)	53	36	889
Cologne (Librarianship & Documentation)	35	20	545
Bad Münstereifel (Law)	57	23	536

[19] Incl. section at Jülich
[20] Incl. section at Gelsenkirchen
[21] Incl. section at Minden
[22] Incl. sections at Aachen, Bielefeld, Cologne, Dortmund, Düsseldorf, Duisburg, Gelsenkirchen, Hagen, Münster, Soest, Wuppertal
[23] Incl. sections at Detmold & Lemgo
[24] Incl. section at Iserlohn
[25] Specialised sections at Aachen, Cologne, Münster, Paderborn
[26] Sections at Mainz (I, II), Bad Kreuznach, Bingen, Höhr-Grenzhausen, Kaiserslautern, Koblenz, Ludwigshafen, Trier, Worms
[27] Incl. section at Koblenz (Police)
[28] Incl. sections at Eckernförde and Rendsburg

Land / Institution	Staff[2] total	Staff[2] academic staff	German & foreign students[3]
Rhineland-Palatinate			
Rhineland-Palatinate[26]	1,013	584	14,355
Mayen (Public Administration EA)[27]	45	29	927
Mainz (Cath. Fachhochschule)	40	26	528
Ludwigshafen (Prot. College for Social Studies)	28	15	333
Hachenburg (German Federal Bank EA)	19	12	300
Edenkoben (Finance EA)	22	15	238
Saarland			
Saarbrücken (Saarland Fachhochschule)	172	96	2,668
Saarbrücken (EA)	6	3	248
Saarbrücken (Cath. College for Social Studies)	19	10	218
Schleswig-Holstein			
Kiel[28]	266	154	4,512
Lübeck	149	74	1,943
Rendsburg (Private Fachhochschule for Correspondence Courses)	–	–	1,102
Wedel (Private Fachhochschule for Physics & Technology)	37	13	992
Flensburg	85	32	915
Altenholz (Administration, Police, & Taxation)	41	27	862

Key
EA – Organised with a College of Administration

Sources: Federal Ministry of Education & Science (Publisher): Reihe Grund- und Strukturdaten, Bonn
Federal Statistics Office, Wiesbaden (Publisher): Personal an Hochschulen 1984, in Bildung und Kultur, Fachserie 11, Reihe 4.4, Mainz 1986.

II. *Main emphases in university research*

1. Overview of the "Special Collaborative Programmes" (Sonderforschungsbereiche) as of January 1986

University/College	Research area
Humanities	
Social Sciences	
(Law, Political Science, Sociology, Economics, Geography)	
U Bielefeld	Preventive action & intervention among children & young people
	Social history of the modern bourgeoisie
U Bochum	Knowledge & society in the 19th century
U Bonn	Information & the co-ordination of economic activities
U Constance	Internationalisation of the economy
	Changing administration – Causes & consequences of processes of differentiation
U Frankfurt/U Mannheim	Microanalytic foundations of social policy
U Mannheim	State allocation policy in the market economy system
U Munich	Developmental perspectives at work
	Theoretical foundations of sociological research into occupational work & manpower
U Siegen (CU)	Aesthetics, pragmatism, & history of small-screen media
Education, Psychology	
U Ulm	Sociological & psycho-physiological analyses of psychotherapeutic processes
History and the Arts	
(Classical Studies, Orientology, History, the Arts, Ethnology)	
U Bayreuth	Processes of cultural & national identity in Africa
U Bonn	Oriental Studies, particularly Central Asia
U Münster	Comparative studies in urban history
U Tübingen	Tübingen Atlas of the Near East
Language and Literature	
(Modern Philology, Literary Studies, & Folklore)	
U Freiburg	Transitions & areas of tension between speech & writing
U Göttingen	Literary translation
U Münster	Pragmatic aspects of writing in the Middle Ages
U Saarbrücken	Electronic linguistic research
U Würzburg/U Eichstätt	The organisation & transmission of knowledge in mediaeval literature

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University/College	Research area
Bio-sciences	
Medicine	
TU Aachen	Artificial organs – models & replacement
TU Berlin	Estimating the risk of pre-natal damage
U Bielefeld/U Münster	Pathobiology of cellular interaction
U Düsseldorf	Research into diabetes
	Coronary heart disease: prevention & treatment of acute complications
	Pathological mechanisms of brain functioning
U Essen (CU)	Experimental & clinical research into leukaemia & tumours
U Freiburg	Clinical & experimental hepatology
	Medical virology (Origins & development of tumours)
	Modulation & learning processes in neuron systems
U Gießen	Mechanisms of pathogenicity in viruses
U Göttingen	Cardiology
U Hamburg	Psychosomatic medicine, clinical psychology, & psychotherapy
U Hamburg/U Lübeck	Functioning & defects in the receptor system
U Hanover	Chronic inflammation
U Heidelberg	Heart functioning & regulation
	Molecular, cellular, & immunological changes & defence mechanisms in malignant illnesses
U Kiel	The lymphatic system & experimental transplantation
U Mainz	Immune pathogenesis
	Control elements in the development of tumours
U Marburg	Tumours & endocrine glands – oncological research in theory & clinical practice
U Munich	Functional adaptation & differentiation in neuron systems
	Foundations & clinical significance of extra-cellular limited proteolysis
	Genetics & regulation of the human immune response
U Regensburg	Experimental chemotherapy in cancer. Synthesis of active substances & testing on hormone-induced tumours
U Tübingen	Implantology
	Leukaemia research & the genetics of immunity
	Neuro-biological aspects of behaviour & pathological deviations
U Ulm	Lympho-haemopoese

University/College	Research area
U Würzburg	Cytological foundations of experimental biology Molecular changes in carcinogenic primary changes
Biology	
TU Aachen (with Jülich nuclear research unit)	Characteristics of biological membranes
U Bayreuth	Regularities & control mechanisms within metabolism in ecological systems
FU Berlin	Membrane processes
TU Berlin	Structure, function, & biosynthesis of peptides & proteins
U Bochum	Biological registration & processing of information – foundations & application Ion gradients for the regulation of cellular functions
U Cologne	Molecular biology of the cell
U Constance	Mechanisms of cellular communication
U Frankfurt	Structure & function of permanent membrane proteins
U Frankfurt/ TU Darmstadt	Comparative neurobiology of behaviour
U Freiburg	Chain reactions of biological signals
U Göttingen	Foundations of cellular interaction & transmission of signals
U Heidelberg	Molecular biology of neural mechanisms & interactions Molecular mechanisms of genetic expression
U Homburg/Saar	Protein phosphorylation & intracellular control of membrane processes
U Marburg	Eco-physiology: processing of environmental signals Cell energetics & differentiation
TU Munich	Biological, chemical, & technical foundations of bio-conversion Registration & processing of information in vertebrates' hearing system
U Munich	Organisation of the eucaryotic genome
U Münster	Intra- and inter-cellular systems of identification
U Osnabrück	Membrane-linked processes of transportation in cells
U Regensburg	Biochemistry of cell surfaces Achievements of the senses: the adaptability of structures & mechanisms
U Tübingen	Micro-biological foundations of bio-technology
U Würzburg	Genetic expression in vertebrate cells Molecular foundations of transmission of signals & transportation of matter in membranes

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University/College	Research area
Agriculture & Horticulture, Veterinary Medicine	
TU Brunswick	Dynamics of water & matter in agricultural & ecological systems
U Hanover	Bio-economic models of horticultural production
U Hanover (Vet. Coll.)/ FU Berlin	Experimental research on animals
U Hohenheim	Appropriate forms of small-scale agriculture in the tropics with a research emphasis on West Africa

Natural Sciences

Mathematics	
U Bonn	Approximation & mathematical optimisation in Applied Mathematics
U Göttingen	Geometry & analysis
U Heidelberg	Stochastic mathematical models
Physics	
FU Berlin	Hyper-sensitive interactions Structure & dynamics of interfaces
U Bielefeld/U Münster	Polarisation & correlation in atomic collisions
U Bochum (with Jülich nuclear research unit)	Plasma-physics
U Cologne	The physics & chemistry of interstellar molecular clouds
U Cologne/TU Aachen (with Jülich NRU)	Magnetic incidence & disorganisation in metals
U Constance	Microscopic & structural processes in atomic & molecular movement
U Duisburg (CU)/ U Bochum	Structural & magnetic phase displacements in transitional metal alloys & compounds
U Erlangen-Nuremberg	Heterogeneous systems at high pressures: apparatus & techniques of measurement, convection, balance, & reactions
U Frankfurt/ TU Darmstadt	Solid-state spectroscopy
U Göttingen/TU Clausthal	Solid-state reactions in volume & on the surface
U Heidelberg	Theoretical & practical stellar astronomy
U Kaiserslautern	Energy transfer in processes of atomic & molecular impact
U Mainz	Medium-energy physics with electro-magnetic interaction
TU Munich	Elementary surface stimuli
U Osnabrück	Oxidised crystals for electro- and magneto-optical applications

University/College	Research area
U Saarbrücken	Ferro-electricity
U Stuttgart	Molecular micro-electronics
U Wuppertal (CU)	Energy states of simple molecules – experimental investigations in quantum theory
Chemistry	
U Bayreuth	Topo-specific chemistry & topo-selective spectroscopy of macro-molecular systems – miscroscopic interaction & macroscopic function
TU Clausthal	Oil technology & chemistry
U Freiburg	Function through organisation in macro-molecular systems
U Göttingen	Photochemistry with lasers
U Hanover	Movement of local particles: convection & chemical reactions in ion crystals
U Mainz	Chemistry & physics of macro-molecules
U Marburg	Crystal structure & chemical bond
TU Munich	Primary processes in bacterial photosynthesis
Geo-Sciences	
TU Berlin	Geo-scientific problems in arid areas (Geology, resources, possibilities of utilisation)
U Frankfurt/U Mainz	Dynamics & chemistry of hydro-meteors
U Hamburg	Climatic processes in the ocean-atmosphere-cryosphere system Interactions between abiotic & biotic processes in the Elbe estuary
TU Karlsruhe	Voltage & its conversion in the lithosphere
U Kiel	Sedimentation in the European North Sea Warm-water sphere of the Atlantic
TU Munich	Satellite geodesy
U Stuttgart	Precision navigation: integration of navigational & geodesic methods

Engineering

General & mechanical engineering	
TU Aachen	Basics & components in flexible operational equipment for mechanical engineering Correlation of the properties of constituent elements in the production of synthetic materials Methods for economising on energy & raw materials in selected production processes Kinetic combustion Focusing of mechanical waves Eddy currents in aeronautics

University/College	Research area
TU Berlin	Computer-based construction models in mechanical engineering
U Bochum	Ramification of performance in propulsion technology
TU Brunswick	Building components' reaction to fire Air safety Laws governing the inelasticity of metals
TU Clausthal	Construction of process-engineering machinery
TU Darmstadt	Technology of surfaces
U Dortmund	Manufacture, processing, & checking of metallic & metallic-ceramic compound materials Systems for flow of materials – Conveyance of piece goods
U Duisburg (CU)	Transmission of energy & matter in aerosols
U Essen (CU)	Basic processes in conversion of coal
U Hamburg-Harburg	Technology of process-oriented measurement & regulation in multi-phase systems
U Hanover	Noise & vibration in machines Tools & manufacturing systems in metal-processing Wear & tear in components used in thermodynamic units
TU Karlsruhe	Stationary constant-pressure combustion in areas of intense heat
TU Munich	Reaction & exchange technology in dispersed two-phase systems
U Stuttgart	Production technology Assembly in flexible production systems
Architecture, Town Planning, and Civil Engineering	
U Bochum	Load-carrying capacity of buildings subject to dynamic influences
U Hanover	Coastal engineering – the impact of rough seas & currents on the construction of harbours & defense systems
TU Karlsruhe	The preservation of historically important buildings The specific demands of silo buildings The mechanics of fluids in building specifications
TU Munich	Qualitative & quantitative flow processes in natural & artificial water-courses
U Stuttgart/ U Tübingen	Natural construction – Light-weight constructions in architecture & nature
Electronics	
TU Karlsruhe/ U Kaiserslautern/ U Saarbrücken	Artifical intelligence – Knowledge-based systems

University/College	Research area
U Munich	Information-processing in autonomously mobile operational systems
U Saarbrücken/ U Kaiserslautern	VLSI planning methods & parallelism

Key:

CU – Comprehensive University
FU – Free University
TU – Technical University
U – University
Vet. Coll. – Veterinary University (Hanover)

Source: German Research Society reports

2. German Research Society "Priority Programmes" as of 1986

Humanities and Social Sciences

Social Sciences
(Law, Political Science, Sociology, Economics, Geography)

Interdependency in the international system
Research into the impact of journalistic media
Contexts of application of the findings of social science
Interactive information & control systems in business management
Inflation & employment in open economies
Economics of natural resources
Research into the genesis of norms and sanctions
Theory of business innovation
Monetary macro-economics
Institutions and methods involved in a peaceful response to international conflict
The origins of militant conflict in Third World states

History and the Arts
(Classical Studies, Orientology, History, the Arts, Ethnology)

Archaeological investigations into settlement in the Alpine foothills
Nepal project
The development of European nations in the Middle Ages
Historical statistics
Man, culture, & environment in the central highlands of West Irian
Western Europe and North America: the history of transatlantic interactions

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Language and Literature
(Modern Philology, Literature, & Folklore)
Forms & functions of intonation
Language acquisition

Philosophy, Theory of Knowledge, Education, Psychology
The physiological psychology of learning
Attitude & behaviour
Psychology of knowledge
Interoception & control of behaviour
Psychological ecology

Bio-Sciences

Medicine
Biology & medical problems of reproduction
Persistent virus infections
Basic mechanisms of post-traumatic progressive lung failure
Aetiology & pathogenesis of inherited illnesses
Pathogenesis of bacteria
Molecular & classical tumour cyto-genetics
Control & further development of dental implants
Nociception & pain
Neuro-peptides
Causes and consequences of insulin deficiency

Nutrition
The metabolism of carbohydrates & lipids in higher organisms

Biology
The molecular biology of higher plants
The cyto-skeleton
Molecular mechanisms in cellular reception of signals
Bio-physics & organisation of cells
Regulation of differentiation among single & oligo-celled eucaryotic systems
Metabolism of inorganic sulphuric & nitrogenous compounds
Methanogene bacteria
Biochemistry of the nervous system
Biological foundations of primate behaviour
Ontogeny of behaviour
Experimental recombination of nucleic acids (Genetic technology)
Metabolism under extreme conditions
The molecular biology & patho-biochemistry of connective tissue
Immune genetics
Physiology and pathology of eicosanoids
Ways towards relevant new bio-technological products
Analysis of human genomes utilising the methods of molecular biology

Issues in ecology, toxicology, and industrial medicine

Integrated system of plant production
Mechanisms of the toxic impact of extraneous matter

Agriculture and Forestry

Nutritional dynamics in the area of contact between plants & soil
Characteristic antagonisms in stock-breeding
Physiology of trees
Origin and function of soil structure

Natural Sciences

Mathematics

Theory of the representation of finite groups and algebras
Computer simulation of grid theories

Physics

Spectroscopy with ultra-short light impulses
The physics of anorganic clusters
High-energy spectroscopy of electronic states in solids & molecules
Diagnosis of hot laboratory plasma

Chemistry

Dynamics of selected chemical primary processes
Thermotropic liquid crystals
New syntheses for the refinement of natural substances
New phenomena in the chemistry of metallic elements with isolated electrons
Non-covalent interactions

Geo-Sciences (Solid Earth)

The kinetics of the processes of rock & mineral formation
Ocean drilling project
Antarctic research
Hydro-geochemical processes in the water-cycle
Digital geo-science maps
The crystal structure, construction, & characteristics of anorganic non-metallic minerals & materials
Substance, structure, & development of the continental sub-crust
Fronts and meso-scalar processes in orographically structured formations

Marine research

"Meteor" expeditions
Evaluation of "Meteor" expeditions

Hydrological research

Toxic substances in ground-water

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Atmospherology

Intermediate atmosphere programme

Engineering

General & mechanical engineering

Laws of matter in engineering construction
Resource-aware design in machine parts
Finite approximations in hydro-mechanics
Building components: production & durability
Technology of precision conversion
Measuring, controlling, & regulating complex-structured dynamic systems
Durability of non-metallic anorganic building components
Data-processing in production technology
Precision processing technology
The physics of separated currents
Thermo-physical characteristics of new materials in energy technology & process engineering
Early recognition of deterioration in metal building components
Diagnostic systems for machines & equipment
New planning and regulatory processes in spheres of indirect production

Architecture, town planning, and construction engineering

Non-linear calculations in construction engineering

Mining and metallurgy

Research into corrosion
Fine crystalline materials
Inter-metallic phases as the basis for new structural materials
Consumption of energy and raw materials in metal-smelting systems

Electro-technology

Digital signal processing
Electricity supplies for densely settled areas
Evaluation of visual & linguistic signals
New systems of electro-mechanical conversion of energy
Integrated optics
Technical foundations of digital communications systems
New conductive & protective processes in the provision of electricity supplies
Physical and technical foundations of III/V semiconductor systems
Data-structures and efficient algorithms

Source: German Research Society reports

III. *Bibliography and sources of further information*

This book summarises existing material. The main sources were:

1. Summarising publications and collections of material

Bericht der Bundesregierung "Hochschulpolitische Zielsetzungen der Bundesregierung und Förderung der Drittmittelforschung" vom 4. 9. 1985, BT-Drs. 10/3728.

Bülow, Andreas von and Haunschild, Hans-Hilger (Ed.): Forschung in der Bundesrepublik Deutschland, Stuttgart, Berlin, Cologne, Mainz [3] 1982.

Der Bundesminister für Bildung und Wissenschaft (Ed.): Reihe Grund- und Strukturdaten, Bonn.

Der Bundesminister für Forschung und Technologie (Ed.): Bundesbericht Forschung 1984, Bonn 1984.

ibid: Faktenbericht 1986 zum Bundesbericht Forschung. Berichte und Dokumentationen, Bonn 1986.

ibid: Gemeinsame Forschungsförderung durch Bund und Länder. Die Zusammenarbeit von Bund und Ländern bei der Gemeinschaftsaufgabe Forschungsförderung nach Artikel 91 b GG, Bonn [3]1981.

DUZ-Universitäts-Zeitung, Redaktion (Ed.): Vademecum Deutscher Lehr- und Forschungsstätten – Stätten der Forschung, Stuttgart [8]1985.

Geimer, H. and R.: Research Organisation and Science Promotion in the Federal Republic of Germany, Munich 1981.

Massow, V. v.: Organisation der Wissenschaft und der Wissenschaftsförderung in der Bundesrepublik Deutschland, Bonn 1969 (For the history of organisations and institutions – otherwise out of date).

Schwerin Krosigk, D. Graf: Grundlagenforschung in der Bundesrepublik Deutschland; RKW-Handbuch Forschung, Entwicklung, Konstruktion (FE), XII, Berlin 1979.

2. Publications (particularly annual reports) by the following official sources, organisations, and foundations

Federal authorities and Laender

Auswärtiges Amt (Foreign Office), Adenauerallee, 99–103, D-5300 Bonn 1, Tel. 0228/171

Bundesminister für Bildung und Wissenschaft (Federal Minister of Education and Science), Heinemannstraße 2, D-5300 Bonn 2 (Bad Godesberg), Tel. 0228/571

Bundesminister für Forschung und Technologie (Federal Minister for Research and Technology), Heinemannstraße 2, D-5300 Bonn 2 (Bad Godesberg), Tel. 0228/591

Ständige Konferenz der Kultusminister der Länder in der Bundesrepublik Deutschland (Standing Conference of Laender Ministers of Education), Nassestraße 8, D-5300 Bonn 1, Tel. 0228/5011

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Bund-Länder-Kommission für Bildungsplanung und Forschungsförderung (Federal-Laender Commission for Educational Planning and Promotion of Research), Friedrich-Ebert-Allee 39, D-5300 Bonn 1, Tel. 0228/54020

Consultancy on scientific policy

Wissenschaftsrat (Science Council), Marienburger Str. 8, D-5000 Köln 51, Tel. 0221/37761

Universities, teachers, and students

Westdeutsche Rektorenkonferenz (WRK – West German Rectors' Conference), Ahrstraße 39, D-5300 Bonn 2 (Bad Godesberg), Tel. 0228/376911

Deutscher Hochschulverband (DHV – Association of University Teachers), Rheinallee 18, D-5300 Bonn 2 (Bad Godesberg), Tel. 0228/355944

Hochschullehrerbund (HLB – Federation of University Teachers), Rüngsdorfer Straße 4 c, D-5300 Bonn 2 (Bad Godesberg), Tel. 0228/352271 (for Technical Colleges)

Vereinigte Deutsche Studentenschaften (VDS – United German Students' Organisations), Kaiserstraße 71, D-5300 Bonn 1, Tel. 0228/223075

Deutsches Studentenwerk (DSW – German Student Welfare Organisation), Weberstraße 55, D 5300 Bonn 1, Tel. 0228/21007

Non-University institutions

Konferenz der Akademien der Wissenschaften in der Bundesrepublik Deutschland (Conference of the Academies of Science in the Federal Republic of Germany), Geschwister-Scholl-Straße 2, D-6500 Mainz, Tel. 06131/5770

Max-Planck-Gesellschaft zur Förderung der Wissenschaften e.V. (Max Planck Society for Promotion of the Sciences), Residenzstraße 1a, D-8000 München 2, Tel. 089/21081

Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V. (Fraunhofer Society for the Promotion of Applied Research), Leonrodstraße 54, D-8000 München 19, Tel. 089/12051

Arbeitsgemeinschaft der Großforschungseinrichtungen (AGF – Association of National Research Centres), Ahrstraße 45, D-5300 Bonn 2 (Bad Godesberg), Tel.: 0228/302250

Arbeitsgemeinschaft Industrieller Forschungsvereinigungen (AIF – Union of Industrial Research Associations), Bayenthalgürtel 23, D-5000 Köln 51, Tel. 0221/376800

Organisations providing assistance for science and young scholars

Deutsche Forschungsgemeinschaft (German Research Society), Kennedyallee 40, D-5300 Bonn 2 (Bad Godesberg), Tel. 0228/8851

Arbeitsgemeinschaft Industrieller Forschungsvereinigungen (AIF-Union of Industrial Research Associations), Bayenthalgürtel 23, D-5000 Köln 51, Tel. 0221/376800

Stifterverband für die Deutsche Wissenschaft (Donors' Association for the Promotion of Sciences and Humanities in Germany), Brucker Holt 56–60, D-4300 Essen 1 (Bredeney), Tel. 0201/711051

Stiftung Volkswagenwerk (Volkswagenwerk Foundation), Kastanienallee 35, D-3000 Hannover 81, Tel. 0511/83810
Fritz Thyssen Stiftung (Fritz Thyssen Foundation), Am Römerturm 3, D-5000 Köln 1, Tel. 0221/234471
Alfried Krupp von Bohlen und Halbach-Stiftung (Alfried Krupp von Bohlen und Halbach Foundation), Hügel 15, D-4300 Essen 1, Tel. 0201/1881
Robert Bosch Stiftung GmbH (Robert Bosch Foundation), Heustraße 1, D-7000 Stuttgart 1, Tel. 0711/223012

Scholarship funds
Studienstiftung des Deutschen Volkes (The German National Scholarship Foundation), Mirbachstraße 7, D-5300 Bonn 2 (Bad Godesberg), Tel. 0228/354091
Cusanuswerk, Bischöfliche Studienförderung (Episcopal Cusanus Scholarship Fund), Annaberger Straße 283, D-5300 Bonn 2 (Bad Godesberg), Tel. 0228/316066
Evangelisches Studienwerk (Protestant Scholarship Foundation), Haus Villigst, D-5840 Schwerte 5, Tel. 02304/7162
Friedrich-Ebert-Stiftung (Friedrich Ebert Foundation), Godesberger Allee 149, D-5300 Bonn 2 (Bad Godesberg), Tel. 0228/8831
Friedrich-Naumann-Stiftung, Bereich Studienförderung (Friedrich Naumann Foundation), Theodor-Heuss-Akademie, Postfach 340129, D-5270 Gummersbach 31, Tel. 02261/65033
Hanns-Seidel-Stiftung (Hanns Seidel Foundation), Lazarettstraße 19, D-8000 München 19, Tel. 089/12581
Hans-Böckler-Stiftung (Hans Böckler Foundation), Schwannstraße 3, D-4000 Düsseldorf 30, Tel. 0211/43011
Konrad-Adenauer-Stiftung (Konrad Adenauer Foundation), Rathausallee 12, D-5205 St. Augustin 1, Tel. 02241/1961

International exchange of scientists
Alexander von Humboldt-Stiftung (Alexander von Humboldt Foundation), Jean-Paul-Straße 12, D-5300 Bonn 2 (Bad Godesberg), Tel. 0228/8330
Deutscher Akademischer Austauschdienst (German Academic Exchange Service), Kennedyallee 50, D-5300 Bonn 2 (Bad Godesberg), Tel. 0228/8821
Fulbright-Kommission (Fulbright Commission), Theaterplatz 1 a, D-5300 Bonn 2 (Bad Godesberg), Tel. 0228/361021

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